ATO
ANALYTICAL MEASUREMENT LAB
BLDG. 23 RM. 623
PHONE 71491

GOULD CARRIER AMPLIFIER
MODEL 13-4615-35
SERIAL NUMBER 385 AND ABOVE

MP MASTER
MA34592

GOULD
Electronics

GOULD
Electronics

MANUAL PART NO.
13-804615-35

GOULD CARRIER AMPLIFIER
MODEL 13-4615-35
SERIAL NUMBER 385 AND ABOVE

The information contained herein is the exclusive property of Gould Inc., except as otherwise indicated and shall not be reproduced in whole or in part without explicit written authorization from the company. The distribution of this material outside the company may occur only as authorized by the company in writing.

All information contained in this manual is the latest product information available at the time of printing. The right is reserved to make changes at any time without notice.

PRINTED 11/84
COPYRIGHT 1982

Gould Inc., Recording Systems Division
3631 Perkins Avenue, Cleveland, Ohio 44114

2ND PRINTING
PRINTED IN U.S.A.

The following information is intended to alert the user to possible dangers and important information contained in this manual. The "WARNINGS" and "CAUTIONS" do not eliminate the dangers that they signal. Close attention to the information supplied plus "common sense" operation are the major accident prevention measures.

WARNING:	**Failure to follow this warning may result in bodily injury.**

CAUTION:	**Failure to follow this caution may result in possible danger to the product or equipment.**

GOULD
Electronics

WARRANTY

CURRENT EQUIPMENT:

Gould Inc.'s Recording Systems Division's products as shown in the Current Equipment Catalog are warranted for a period of one year from date of shipment to original purchaser. Exceptions: the thermal pen in the 110 Strip Chart Recorder is guaranteed for life; the magnetic head assemblies in the Tape Recorder are warranted for 1000 hours of use or one (1) year from date of first shipment whichever occurs first; and the mainframe computer for Data Acquisition Systems and their associated software programs are warranted for 90 days.

Gould's products are warranted to conform to the applicable published specifications in effect at the time of shipment, and to be free from any defects in material or manufacture when used with recommended Gould associated equipment and Gould chart paper. GOULD'S LIABILITY UNDER SUCH WARRANTY IS LIMITED TO SERVICING OR REPLACING DEFECTIVE PARTS EXCEPT PENS, STYLI, FUSES AND BATTERIES AND DOES NOT INCLUDE CALIBRATION AND MINOR MAINTENANCE AS OUTLINED IN GOULD OPERATING MANUALS. IN NO EVENT SHALL GOULD BE LIABLE UNDER ANY CIRCUMSTANCES, FOR ANY LOSS OF PROFITS OR OTHER CONTINGENT, CONSEQUENTIAL OR SPECIAL DAMAGES. All products are to be returned transportation prepaid by the buyer. Gould reserves the right to determine the cause and existence of a defect under this warranty and this warranty shall not apply to any products which have been subjected to misuse, improper installation, repair, alteration, neglect, accident, inundation, fire or operation outside their published maximum ratings.

THE FOREGOING WARRANTY IS EXCLUSIVE AND EXPRESSLY IN LIEU OF ALL OTHER WARRANTIES WHETHER EXPRESSED OR IMPLIED, INCLUDING ANY IMPLIED WARRANTIES OF MERCHANTABILITY OR FITNESS AND OF ANY OTHER OBLIGATION AND SHALL CONSTITUTE THE SOLE REMEDY OF THE BUYER AND SOLE LIABILITY OF GOULD.

Gould offers an Extended Warranty Agreement for all its products, along with calibration traceable to NBS. Please contact the Service Center listed on the following pages for details before your warranty expires.

REPLACEMENT PARTS: Warranty is same as above except ninety (90) days from date of shipment.

If a defect occurs:

1. Notify your nearest Gould Service Center giving full details of the difficulty, and include the product model number, and serial number. On receipt of this information, service data or shipping instructions will be provided.

Compliance with the above procedure will assure the earliest repair and return of your equipment.

5/22/84

Gould instruments are individually tested and calibrated before shipment to assure dependability and verify their accuracy. To this procedure must be added an unseen ingredient of prime importance to you: The Gould concept of continuing service. Gould responsibility for each instrument sold covers far more than its delivery. Of equal concern is the equipment's suitability for its intended purpose, its correct installation, instruction of operating personnel -- plus future servicing and maintenance. The Gould Field Service Department offers customers any or all of these services:

Field Service

- o Installation
- o Field maintenance
- o NBS Certification

Training

- o Instruction of operators
- o On-site training seminars
- o Formal Training courses

Service Contracts

- o Fixed Fee
- o Time and Material
- o Extended Warranty

Our Seal of Pride Gould Inc., Recording Systems Division, and its predecessor organizations tracing back to Charles F. Brush, have been preeminent in instrumentation development since the 1920's. Among Gould's many achievements is a series of the world's best performing, most versatile, and reliable direct writing recording systems.

Today, Gould recorders and signal conditioners are the overwhelming choice for recording analog signals in the most critical industrial, scientific, and biophysical measurement applications. Whether recording the faintest life signals of a patient in a hospital operating room or the most critical variables in the lab or on the production line, you can depend on the accuracy, faithfulness, clarity, and permanence of the traces made by a Gould recorder.

Innovative design, coupled with highest quality, are hallmarks of all Gould products.

The Field Service Engineer Gould field service engineers provide on-the-spot assistance whenever and wherever it is required. While every field service engineer is the product of intensive and thorough factory training, you will find that his greatest strength evolves from field experience and his knowledge of your objectives. He is aware of your problems, is willing and able to assist you in their solution, and is backed by the nation's most experienced organization in recording instrumentation.

Our field service engineers and technicians are daily engaged in the installation, testing, maintenance, repair and inspection of Gould recording systems all over the country. They can provide you with any information about our instruments you may require; if not, they will find the answer to your problem.

Overhaul and Repair Because we service only our own products, our customers can feel confident of prompt, effective results when they turn to Gould Factory Service Centers.

The repair service these centers provide is of particular appeal to those companies that do not operate an instruments repair facility of their own. By designating the nearest Gould Service Center as its maintenance depot, a Gould-equipped company is assured the best chance for continuity of recording instrumentation.

Many companies with their own repair facilities find it more convenient and more truly economical to have their Gould equipment repaired by service contract with the closest Service Center. In addition to enjoying fast turn-around, these companies are spared the expense of carrying an inventory of recorder parts, accessories, and supplies.

Calibration and Certification A small, quiet room in the Standards and Calibration Section at the Gould plant in Cleveland contains precision reference standards just one step removed from the prime reference measurement standards of the United States – at the National Bureau of Standards in Washington. Included in this room which is temperature-controlled within one degree and has a constant relative humidity of 40%, are standards for voltage, frequency (derived from the atomic vibration of caesium), resistance, capacitance -- in fact all basic parameters of electrical measurement. The room is maintained under stabilized conditions 365 days a year.

The calibration practice of all Gould Service Centers is directly traceable to the National Bureau of Standards. We can supply complete calibration for any Gould equipment, and we can also certify to manufacturer's specifications followed by a letter of certification when required.

Training The Gould field service engineer will hold short training courses either on the job or at his facility. On-the-job training is usually a brief, informal session with the people who will actually be operating the Gould equipment.

Formal classroom training is more complete: detailed information, a thorough review of underlying theory, training devices, demonstration of problem solving and examination of students to determine their understanding and proficiency is accomplished at our Cleveland plant.

Contracts Customer companies requiring temporary or permanent service are afforded contract arrangements by which agreed-upon maintenance, repair, upgrading and calibration services are performed on a routine basis. Service contracts are now in effect with a number of customers, affording substantial savings in time and money.

Owing to the various requirements of each customer, we do not reproduce here a standard, boilerplate agreement -- which might contain too much or too little. Instead, we tailor each contract to a particular customer's needs. This practice has singlehandedly produced substantial savings in time and money for others; and it can do the same for you.

An extended warranty is available at the point of sale allowing a regulated budget for the first two years of ownership. You may take advantage of this warranty within the first year of ownership at a percentage of the current listed price.

SERVICE CENTERS

ATLANTA
RECORDING SYSTEMS DIVISION
1710 Wilwat Drive, Suite D
Norcross, Georgia 30093
Phone: (404) 441-5556

BOSTON
RECORDING SYSTEMS DIVISION
Middlesex Technical Center, Building No. 5
900 Middlesex Turnpike
Billerica, Massachusetts 01821
Phone: (617) 667-8550

CHICAGO
RECORDING SYSTEMS DIVISION
1550 East Higgins Road
Suite 122
Elk Grove Village, Illinois 60007
Phone: (312) 640-4380

CLEVELAND
RECORDING SYSTEMS DIVISION
3631 Perkins Avenue
Cleveland, Ohio 44114
Phone: (216) 361-3315

DAYTON
RECORDING SYSTEMS DIVISION
432 Windsor Park Drive
Centerville, Ohio 45459
Phone: (513) 433-9586

DENVER
RECORDING SYSTEMS DIVISION
1500 West Hampden Avenue Unit 1C
Englewood, Colorado 80110
Phone: (303) 781-4473

DETROIT
RECORDING SYSTEMS DIVISION
32307 Mally Road
Madison Hts., Michigan 48071
Phone: (313) 588-4024

HOUSTON
RECORDING SYSTEMS DIVISION
10500 Northwest Freeway
Houston, Texas 77092
Phone: (713) 680-1121

LOS ANGELES
RECORDING SYSTEMS DIVISION
16310 Arthur Street
Cerritos, California 90701
Phone: (213) 404-1919

ORLANDO
RECORDING SYSTEMS DIVISION
772 Northlake Avenue
Altamonte Springs, Florida 32701
Phone: (305) 830-0695

PHILADELPHIA
RECORDING SYSTEMS DIVISION
1 Great Valley Parkway East Suite 6
Great Valley Corporate Center
Malvern, Pennsylvania 19355
Phone: (215) 647-2214

PITTSBURGH
RECORDING SYSTEMS DIVISION
585 Rugh Street
Suite A
Greensburg, Pennsylvania 15601
Phone: (412) 838-7700

ROCHESTER
RECORDING SYSTEMS DIVISION
200 Buell Road
Rochester, New York 14624
Phone: (716) 235-4980

SADDLEBROOK
RECORDING SYSTEMS DIVISION
74 Kenney Place
Saddlebrook, New Jersey 07662
Phone: (201) 845-0220

SAN FRANCISCO
RECORDING SYSTEMS DIVISION
26102 Eden Landing Road
Hayward, California 94545
Phone: (415) 782-0852

TORONTO
ALLAN CRAWFORD ASSOC., LTD.
6503 Northam Drive
Mississauga, Ontario, Canada
Phone: 678-1500

WASHINGTON, D.C.
RECORDING SYSTEMS DIVISION
6301 Ivy Lane Suite 106
Greenbelt, Maryland 20770
Phone: (301) 345-0050

EUROPE

GOULD INSTRUMENTS S.A.F.
57 rue St. Sauveur 91160
Ballainvilliers, France
Phone: 011-33-6-934-1067

GOULD BRYAN INSTRUMENTS LTD.
14/16 Wates Way
Mitcham, Surrey CR4-4HR, England
Phone: 01-640-3490

GOULD INSTRUMENTS GMBH
Dieselstrasse 5-7
D-6453 Seligenstadt,
West Germany
Phone: 06182-3107

TABLE OF CONTENTS

SECTION	TITLE	PAGE
I	GENERAL INFORMATION	
1.1	INTRODUCTION	1.1
1.2	SPECIFICATIONS	1.1
II	INSTALLATION	
2.1	GENERAL	2.1
2.2	INITIAL INSPECTION	2.1
2.3	INSTALLATION	2.1
2.4	INPUT CONNECTIONS	2.1
2.5	POWER AND OUTPUT	2.2
2.6	PRELIMINARY SET-UP	2.3
2.7	EXTENDING YOUR RANGE OF BALANCE	2.3
2.8	SIGNAL CABLE CONNECTIONS	2.3
2.9	PREAMPLIFIER POLARITY	2.4
2.10	THE LVDT	2.5
2.11	THE 11-5407-35 ADAPTER ARM	2.5
2.12	OUTLINE DIMENSIONS	2.5
III	GENERAL	
3.1	GENERAL	3.1
3.2	FRONT PANEL CONTROLS	3.1
3.3	INTERNAL CONTROLS	3.3
3.4	PLUG-IN COMPONENT TERMINALS	3.4
3.5	BRIDGE CALIBRATION	3.6
3.6	OPERATION	3.7
3.7	USING ZERO SUPPRESSION	3.7
3.8	OUTPUT - CHANNEL 2	3.7
3.9	FUNCTIONAL TEST PROCEDURE	3.8
IV	THEORY OF OPERATION	
4.1	AMPLIFIER	4.1
4.2	REFERENCE	4.1
4.3	BASIC CARRIER DESIGN	4.1
4.4	MASTER OSCILLATOR	4.2
4.5	EXCITATION DRIVE	4.2
4.6	PREAMPLIFIER	4.2
4.7	CHANNEL 1	4.3
4.8	CHANNEL 2	4.3
4.9	AUTO PHASE	4.3
4.10	AUTO BALANCE	4.4
V	MAINTENANCE AND CALIBRATION	
5.1	MAINTENANCE	5.1
5.2	CALIBRATION	5.1
5.2.1	General	5.1
5.2.2	Equipment Required	5.1
5.2.3	Preliminary Procedure	5.1
5.2.4	Calibration Procedure	5.2
VI	PARTS IDENTIFICATION	
6.1	GENERAL	6.1
6.2	ATTACHING PARTS	6.1

LIST OF ILLUSTRATIONS

FIGURE	TITLE	PAGE
1-1	GOULD 13-4615-35 CARRIER AMPLIFIER	1.1
2-1	REAR VIEW	2.1
2-2	INPUT CONNECTOR PIN CONNECTIONS	2.2
2-3	CARD EDGE CONNECTIONS	2.2
2-4	TYPICAL SIGNAL CONNECTIONS	2.4
2-5	PREAMPLIFIER POLARITY	2.5
2-6	SENSITIVITY CONTROLS	2.6
2-7	TYPICAL LVDT SIGNAL CONNECTIONS	2.6
2-8	11-5407-35 ADAPTER	2.7
2-9	OUTLINE DIMENSIONS	2.7
3-1	FRONT PANEL CONTROLS	3.2
3-2	INTERNAL CONTROLS	3.5
3-3	TEST INPUT CIRCUIT	3.8
4-1	BASIC CIRCUIT	4.1
4-2	BLOCK DIAGRAM	4.5
5-1	TEST SET-UP	5.2
5-2	COMMON MODE TEST FIXTURE	5.3
5-3	OSCILLOSCOPE WAVEFORMS	5.3
6-1	CARRIER AMPLIFIER, MODEL 13-4615-35	6.4
6-2	BOARD ASSEMBLY 894952	6.9

SECTION I

GENERAL INFORMATION

1.1 INTRODUCTION

The Gould Model 13-4615-35 Carrier Amplifier, Figure 1-1, is our latest answer to balancing, measuring and amplifying low level signals from carrier excited transducers such as strain gages, variable differential transformers or reluctance type transducers. The unit supplies an adjustable 1 to 10 volt RMS, 2.5KHz signal for transducer excitation. Provision has been made internally for bridge completion resistors if one or two active bridge transducers are used.

The Main Unit features are Automatic Phase Control and Automatic Zero Balance on command. Remote Automatic Balance is available through the output connector.

Another new feature is the Master/Slave Synchronization Switch. This is used when you are using more than one carrier amplifier. One amplifier is selected as the master, and the others as slave. This eliminates interaction between the oscillators in each of the carrier units.

The amplifier has two outputs. Channel number one's output is 0 to 5VDC with zero suppression and variable gain of from 20 to 50,000. This channel is used primarily to furnish a signal to the 2000 Series recorder.

Channel number two provides a 0 to 10 volt output with a variable gain of from 100 to 10,000. This output is set up for digital displays, etc. Both channels have direct and average filtering available with corner frequencies of 200 or 0.05Hz with 12dB/octave roll-off.

FIGURE 1-1 GOULD 13-4615-35 CARRIER AMPLIFIER

1.2 SPECIFICATIONS

Amplifier Input

Circuit Configuration ..... Full Floating and Differential.

Input Impedance..... 1 Megohm at 2.5KHz floating and guarded.

Measurement Range . . . +/-100μV to +/-1V RMS for full scale output at a calibration factor of 1.

Input Attenuator Inaccuracy.....X1, X100 (internal switch. +/-.25% of full scale).

Calibration Factor . . . . . Front Panel (Duodial)

Range . . . . . 0.5 to 10.5.

Resolution . . . . . +/-0.05% of Full Scale.

Non-Linearity . . . . . +/-0.25% of Full Scale.

Auto Balance . . . . . Front Panel Switch, Indicator.

Range . . . . . 0 to +/-10mVRMS (R&C Balance).

Resolution (with 18K ohm R Bal Resistor) . . . . . 11 Bit.

Non-Linearity . . . . . ±4 LSB out of 12 Bit DAC.

Remote Command . . . . . TTL compatible.

Common Mode Rejection . . . . . Greater than 120dB at 60Hz with 350 ohm unbalance from input to chassis. At 100μV sensitivity.

Leakage Current . . . . . Less than 10μA RMS between any input terminal, including the excitation, and chassis with 120VRMS 60Hz applied per UL544.

Maximum Safe Voltage

Common Mode . . . . . 500VDC or Peak AC from the input terminals to chassis.
Normal Mode . . . . . 50VDC or Peak Ac between input terminals.

Terminals Provided for (internal) . . . . . 3 Bridge completion resistors.
1 Calibration resistor.
1 Zero Balance resistor.

Instability . . . . . (30 minute warm-up) Most sensitive scale.

Zero - Time . . . . . 0.05% of full scale/24 hours.

Temperature . . . . . 0.1% of full scale/Degree C.

Line . . . . . 0.1% of full scale/10% line variation.

Gain - Time . . . . . 0.05% of reading/24 hours.

Temperature . . . . . 0.08% of reading/Degree C.

Line . . . . . 0.1% of reading/10% Line Voltage change.

Channel 1 Output

Voltage . . . . . 0 to +/-5VDC into a 2K ohm load with 0.02 μfd capacitor or greater in parallel.

Impedance . . . . . Less than 5 ohms (short protected).

Calibration Error . . . . . +/-0.1% of full scale.

Non-Linearity . . . . . +/-0.1% of full scale.

Noise . . . . . With 350 ohm input unbalance and direct filter less than 10 μvolts p-p.

Frequency Response

Direct ..... DC to 200Hz, 6dB down at 200Hz. +/-15%.

Average ..... DC to 0.05Hz, 6dB down at 0.05Hz +/-20%. 12dB/octave roll-off.

Attenuator

Steps ..... OFF, 1000, 500, 250, 100, 50, 25, 10.

Inaccuracy ..... +/- 0.25% between steps.

Equivalent Input Signal ..... Short, 10, 5, 2.5, 1, .5, .25 and 0.1 mV at a calibration factor of 1.

Sensitivity

Range ..... >2.5 to 1 variation also detent X1.

Maximum Linear Input Voltage ..... 10 volts RMS, sinusoidal, at 2.5KHz.

Zero Suppression

Range ..... +/-100 or +/-1000 referred to the input.

Resolution ..... +/-0.05% F.S.

Non-Linearity ..... +/-0.25% F.S.

Calibration ..... +/-0.1% independent of transducer phase.

Channel 2 Output Voltage ..... 0 to +/-10VDC into a 2Kohm load with 0.02μfd capacitor in parallel.

Impedance ..... Same as Channel 1.

Calibration Error ..... Same as Channel 1.

Non-Linearity ..... +/-0.1% of Full Scale, X1 Gain.

Gain ..... (internal switch X1-X10)

X1 Position ..... 1mVRMS input = 1VDC output.

X10 Position ..... 1mVRMS input = 10VDC output.

Noise ..... Same as Channel 1.

Frequency Response ..... Same as Channel 1.

Instability ..... Same as Channel 1.

Direct-Average Filter ..... Internal Switch. This switch is overridden to direct position when the Front Panel, Cal-Dir-Avg Switch is placed in Cal. position.

Transducer Excitation

Voltage ..... Internally adjustable from 2 to 10VRMS. Max. load 0.250 watts.

Frequency ..... .2500Hz +/-5% Sine Wave.

Total Harmonic Distortion ..... Less than 0.25% at 5VRMS amplitude.

Phase Demodulator ..... Automatic in-phase with signal.

Synchronization ..... .Jumper selectable, master to 7 slaves.

Phase Reference 0° or 90° ..... Internal switch selectable.

Normal-Reverse ..... Internal switch selectable.

Amplitude Instability ..... (30 minute warm-up)

Time ..... .+/-0.02%/24 hours.

Temperature ..... +/-0.1%/Degree C with 350 ohm load.

Line ..... .+/-0.01%/10% Line Voltage change.

Load Regulation ..... 20% No Load to Full Load with a 350 ohm load.

Power Requirements ..... +15VDC @ 125mA.
-15VDC @ 125mA.
13VAC @ 60Hz @ 200mA.

Accessories:

Mating Connector 11-5407-50

Transducer Adapter (Validyne, LVDT) 11-5407-35

Starter Kit ..... .696238

Board Asm. Extender ..... .887291

Resistor R1-288308-13500

Resistor (Bridge) 242879-121

Resistor (Bridge) 242879-351

Resistor (Balance) 25-265969-15001

Resistor (Balance) 25-265969-50001

SECTION II

INSTALLATION

2.1 GENERAL

This section describes the checks and inspections that should be made upon receiving the Gould Carrier Amplifier, Model 13-4615-35 with a 2000 series unit. It covers installation procedures, signal input connections, and outline dimensions.

2.2 INITIAL INSPECTION

Prior to attempting any electrical connections or operation visually examine the unit for broken or loose knobs, dented or nicked panels and broken or chipped rear connectors.

2.3 INSTALLATION

Preamplifier Model 13-4615-35 may be mounted in Gould 2000 Recorder frames, Gould portable case or rack mounted separately in a Gould rack adapter kit.

1. **Insertion**

   (Paragraph 2.6 PRELIMINARY SET-UP, must be completed before insertion.)

To install the preamplifier into it appropriate slot:

a. Slide the preamplifier into the enclosure until the rear output card edge connector is engaged. See Figure 2-1, REAR VIEW.

b. Tighten the rear retaining screw until the preamplifier front panel is flush with the edge of the enclosure. DO NOT OVERTIGHTEN. This locks the preamplifier into the enclosure.

c. Connect the input signal connector and secure it by grasping rear of connector and pushing it onto the female connector after vertical alignment of the blue index mark. When a click is heard or an orange ring appears, the connector is locked in place.

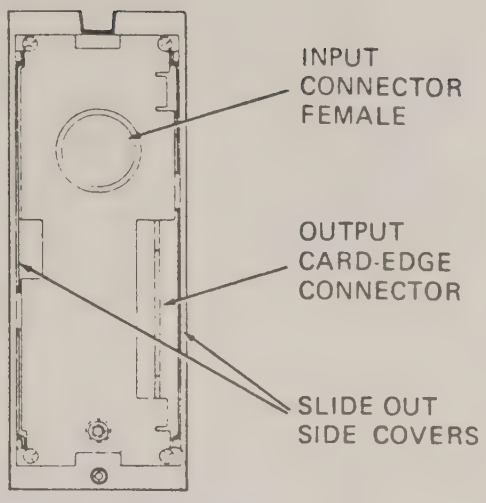


FIGURE 2-1 REAR VIEW

2. **Removal**

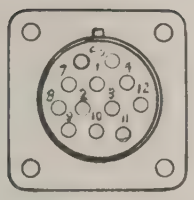
a. Disconnect the input connections with a counterclockwise turn to the connector and pull.

b. Loosen the rear retaining screw. The preamplifier will move forward about 1/8 of an inch.

c. Carefully slide the entire preamplifier out of the Gould 2000 enclosure.

2.4 INPUT CONNECTIONS

Figure 2-2 shows the pin connections located at the rear of the Carrier Amplifier. For the convenience of the user, a mating guarded, multi-pin connector (Gould Model 11-5407-50) is supplied. See Paragraph 2.8 for a typical wiring diagram.



PIN	FUNCTION
11	Signal (+)
12	Signal (-)
8	Excitation (-)
9	Excitation (+)
7	Shunt Cal.
10	Isolated common

FIGURE 2-2 INPUT CONNECTOR J101
PIN CONNECTIONS

2.5 POWER AND OUTPUT

Output and Power connections are made through a 16 pin card-edge connector. Refer to Figure 2-3 for wired connections. These connections to the recorder are already made, inside the system.

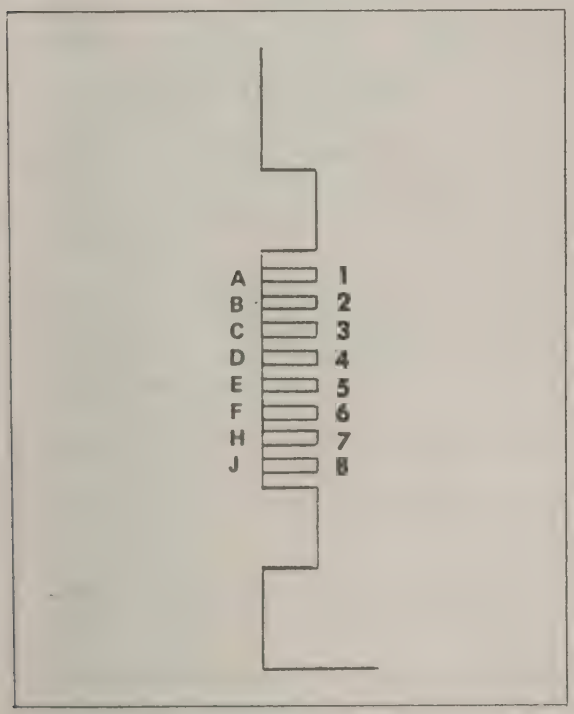


FIGURE 2-3 CARD EDGE CONNECTIONS
XA201

PIN NO.	FUNCTION
1	*Common
2	Channel 1 Recorder Out
3	(-) 15 Volts
4	(+) 15 Volts
5	*Signal Common
6	Master/Slave Sync.
7	*Common 13 Volts AC
8	13 Volts AC
A	N.C.
B	Channel 1 Output
C	Remote Auto-Bal. Signal
D	N.C.
E	N.C.
F	N.C.
H	N.C.
J	Channel 2 Output

*Commons are tied on board to chassis ground.

2.5.1 Multi-Carrier Operation

Operating more than one Carrier in a system may require a synchronizing lead. That is, pin 6 of all the carrier channels are wired together. One Carrier Amplifier is selected as master and the master-slave jumper is left at E4-E5 (see Fig. 3-2). All other amplifiers are considered slaves, and the jumper is moved to E5-E6.

2.6 PRELIMINARY SET-UP

a. External - Adjust the controls as follows:

Full Scale control to OFF.
Cal-Dir-Avg switch to Dir.
Bal-ON-OFF switch to ON.
Zero Suppression OFF.
Calibrate set on 4
Sensitivity set at detent (X1).

b. Internal (Remove right hand cover and adjust.)
(Reference Sections 3.3 and 3.4.)

Check for Jumpers at E1-E2 and E4-E5.

Switch S1 (X100-X1) in X1 position.

Switch S2A (X1-X10) in X10 position.

Switch S2B (D-A) in D position.

Switch S-3A (N-R) in N position.

Switch S-3B (0-90) in 0 position. Replace cover.

c. Assuming your transducer is a 4 active element type, follow this set-up to completion. If yours is a 1 or 2 active element type, add bridge completion resistors.

Install Carrier Amplifier in proper channel.

Plug in the cable from the transducer you are going to use.

Make sure the transducer is in an at rest position (no load).

The excitation is set at the factory at 5VRMS, with a load (see Section 5, Calibration). If necessary the excitation voltage can be set between 2 and 10 VRMS by adjusting R-16 and monitoring TP-10 and 11.

Turn power on to the recorder and preamplifier.

Allow for a 15 minute warm up.

Adjust the pen position to the center of the Channel.

Turn the F.S. control to 1000.

Switch the Bal-On-Off switch to Bal. Hold momentarily.

The Phase light and then the Bal light will glow and the pen will return to the chart center.

Your system is balanced.

If your system is unable to be balanced an oscillation will occur. The pen will swing to the edge of the chart and then back toward the middle slowly (about 2 cps) but will not go to the center. If this indication occurs see Note.

NOTE: Your system will allow you to balance a 40mV input (error) signal. This figure is arrived at by multiplying the amplifier gain at 10mV (with 18K ohm "R" Balance Resistor) and the Calibrate setting of (4). If lower sensitivities are required, a higher number can be adjusted on the Calibrate control, and/or X100-X1 switch can be moved. Your total range of operation is from 10mV to 10V.

You can now change the FS attenuator to your desired sensitivity. Also the calibrate control for proper amplification.

2.7 EXTENDING YOUR RANGE OF BALANCE

This amplifier has a gain of about 2.5 to 25 controlled by the front panel calibration control. Figure 2-6 shows the controls used to change the sensitivity.

a. The amplifier, as stated, has an allowable 10mV input signal range because of the 18K ohm resistor in the R Balance position. If it were necessary to increase the sensitivity to 1mV we could install a 1.3Kohm resistor.

The formula for computing the R balance resistor is:

$$R_{bal} = \frac{45.54\ e(in)}{.036 - e(in)}$$

Where R bal is in Kohms and e(in) is in volts. E(in) is the desired balance range and should be limited to $<.025V$.

NOTE: **It should be remembered that the higher the R balance resistance, the more coarse the balance will be.**

2.8 SIGNAL CABLE CONNECTIONS

1. Use a four conductor, double foil, shielded signal cable Belden No. 8434, or equivalent.

   The cable run from transducer to preamplifier should be one continuous length. NO SPLICES ARE PERMITTED, but mating low level signal connectors may be used if necessary.

2. Connect the double shielded signal cable pair to preamplifier signal input connector, pins 11 and 12.

3. Connect the shielded signal cable pair to transducer excitation pins 8 and 9 as shown in Figure 2-4.

4. Some bridges include a "shunt resistor" for use in calibration. If so, it should be connected to pin 7 and a jumper must be placed in the "Cal R" spot (see Figure 3-2). IF NOT, PIN 7 MUST BE JUMPERED TO PIN 9 IN THE INPUT CONNECTOR. (Internal "Cal R" will be installed in Paragraph 3.5.)

5. Connect the signal cable shield to pin 10 located in the input connector and ground the signal cable shield at the transducer as shown in Figure 2-4.

NOTE: The transducer enclosure should be grounded at the transducer.

It is important that the signal cable shield be insulated from the metal shell of the preamplifier input connector. If this is not done "ground loop" noise will be created by circulating currents in the signal cable shield between the transducer ground and the preamplifier chassis ground.

2.9 PREAMPLIFIER POLARITY

1. When a POSITIVE signal is applied to a transducer we would expect the pen on the recorder chart to move from chart center to the LEFT. To accomplish this, the transducer is connected as shown in Figure 2-4.

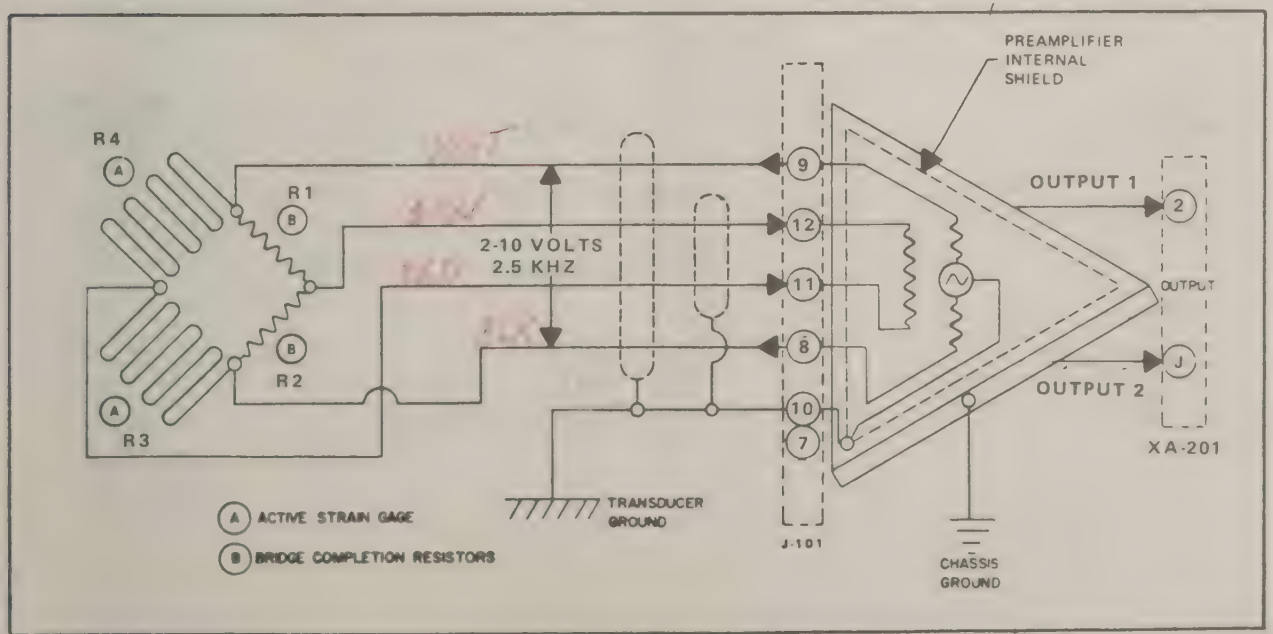


FIGURE 2-4 TYPICAL SIGNAL CONNECTIONS

2. Examination of Figure 2-5 will reveal that there is a polarity reversal between the preamplifier input and output. This is done to compensate for the polarity reversal that occurs in Gould pendrive amplifiers.

3. POLARITY REVERSAL is accomplished by simply switching the internal switch, (N-R) from Normal to Reverse. This switch inverts the oscillator output.

2.10 THE LVDT

a. A typical connection of an LVDT to the carrier preamplifier can be seen in Figure 2-7. The center coil is the driven coil and obtains its signal from the excitation output pins 8 and 9. The two pickup coils are hooked in series and sent to the input amplifier via input pins 11 and 12.

b. The only change in set-up procedure, paragraph 2.6b, is the X100-X1 switch is placed in the X100 position. The reason is, most LVDT's have very high output, usually in the volts range.

2.11 THE 11-5407-35 ADAPTER ASSEMBLY

This Adapter, Figure 2-8, was designed to mate Validyne type transducers with the 13-4615-35 Carrier Amplifier. It will also reduce the carrier input signal by a factor of approximately 20 to 1 to accommodate the relatively high Validyne transducer outputs.

2.12 OUTLINE DIMENSIONS

Preamplifier outline dimensions are shown in Figure 2-9.

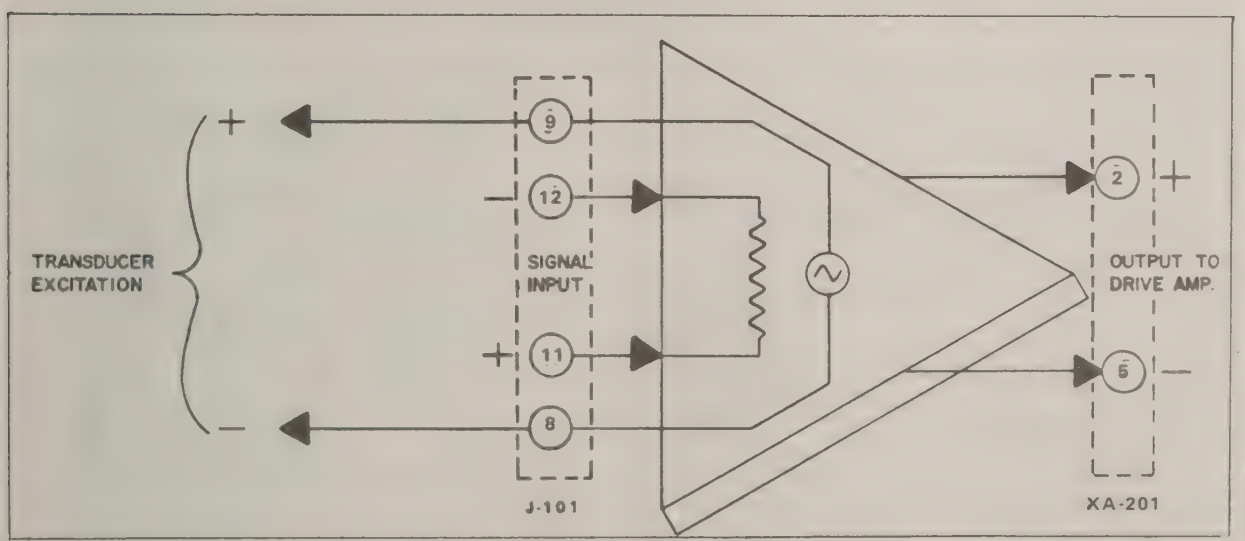


FIGURE 2-5 PREAMPLIFIER POLARITY

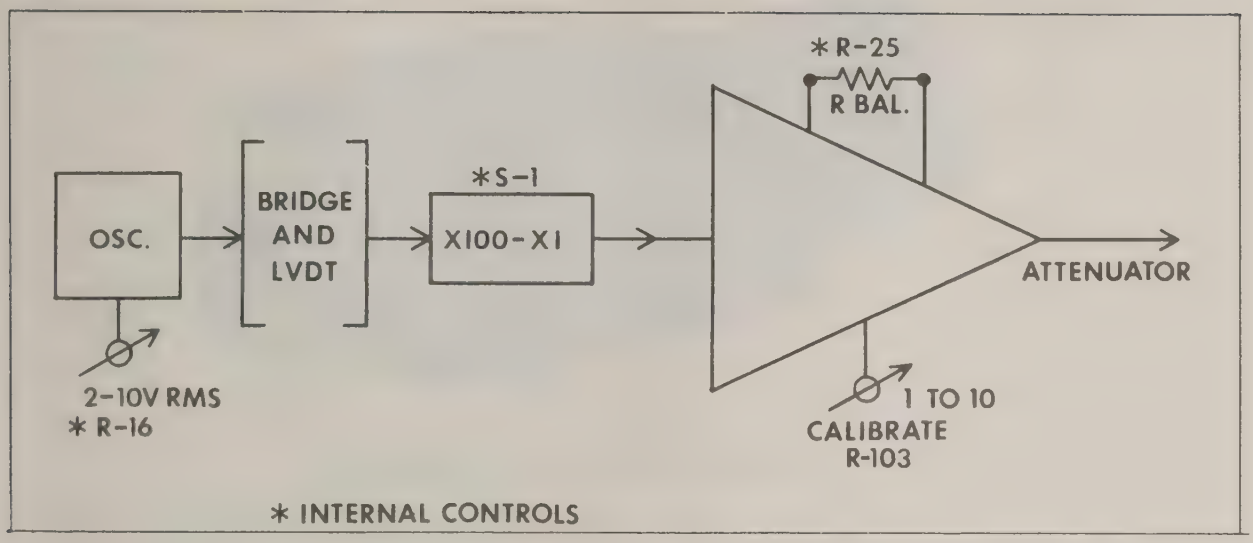


FIGURE 2-6 SENSITIVITY CONTROLS

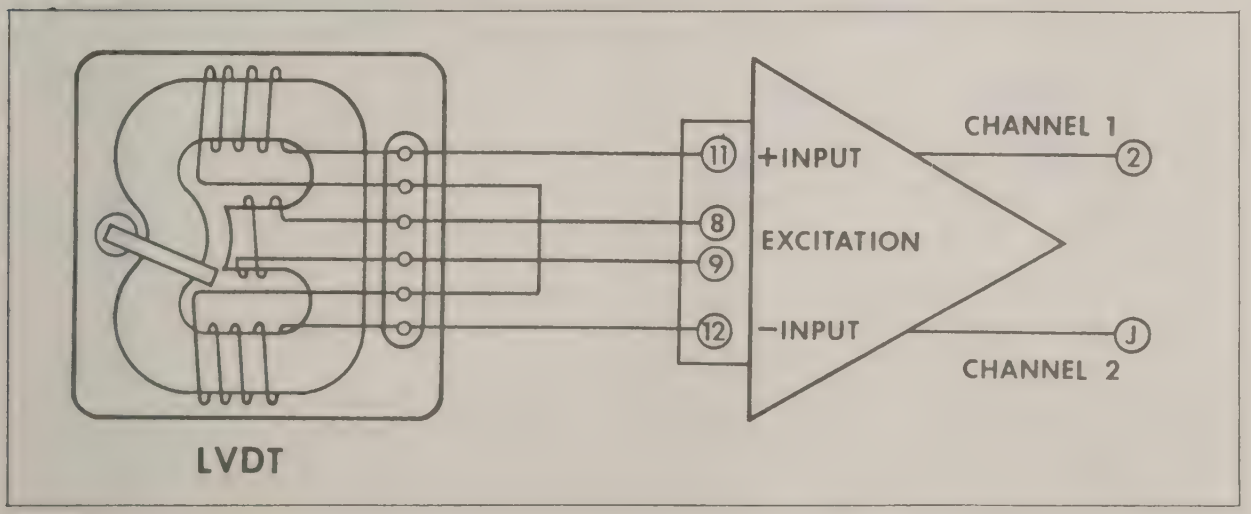


FIGURE 2-7 TYPICAL LVDT SIGNAL CONNECTIONS

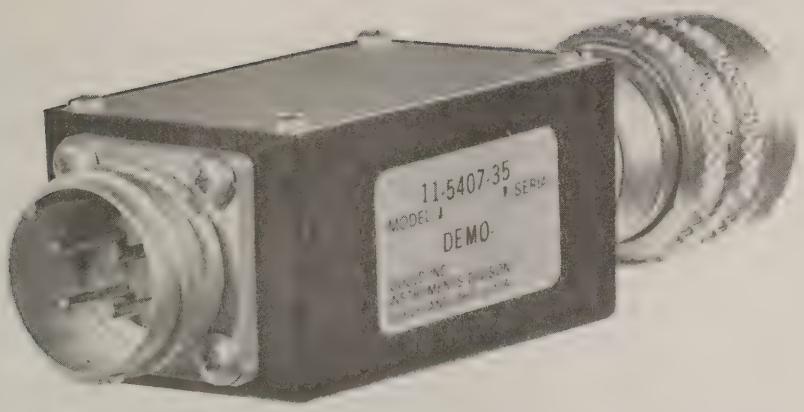


FIGURE 2-8 11-5407-35 ADAPTOR

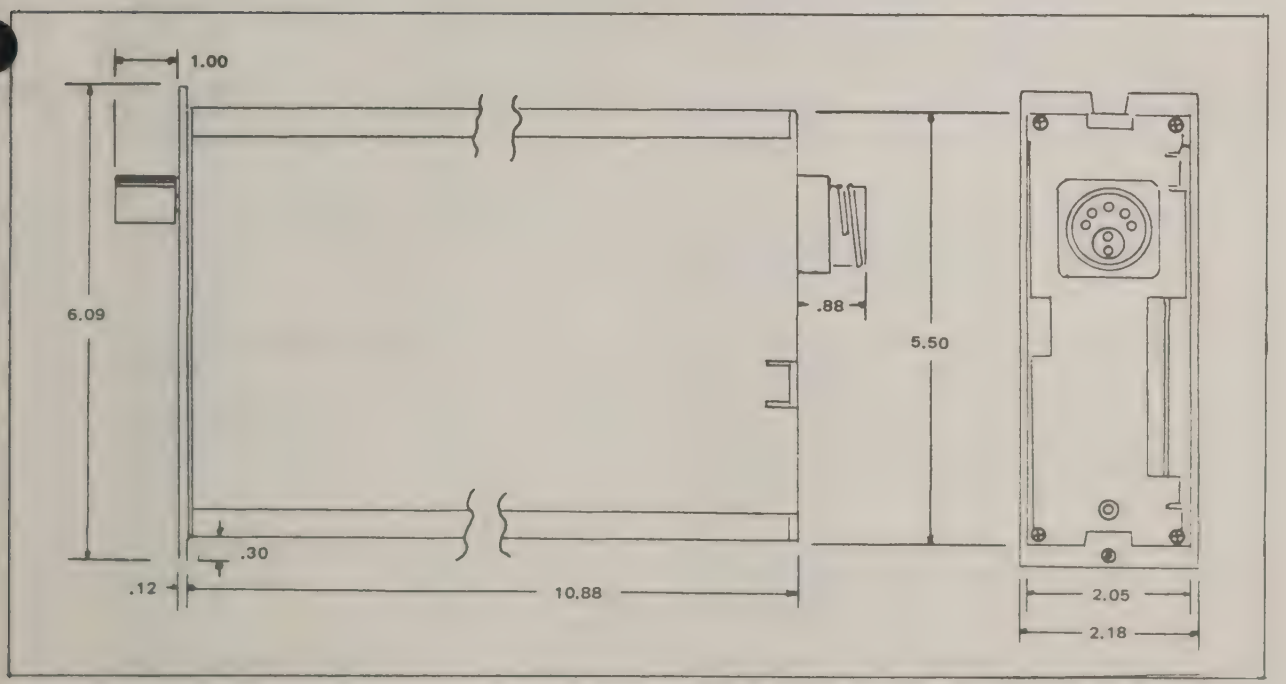


FIGURE 2-9 OUTLINE DIMENSIONS

SECTION III

OPERATION

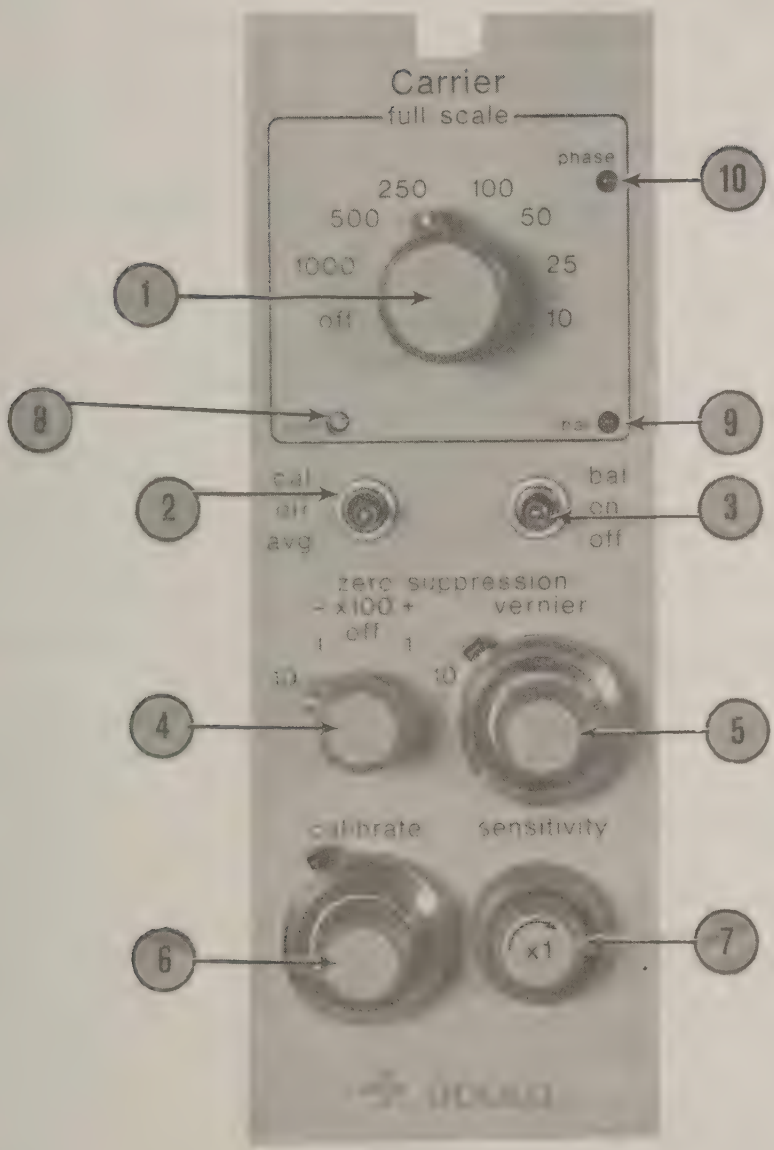
3.1 GENERAL

This section describes and illustrates the controls of the Carrier Amplifier, Model 13-4615-35,and provides complete operating instructions.

3.2 FRONT PANEL CONTROLS

Item numbers listed below refer to circled numbers in Figure 3-1.

ITEM	CONTROL	DESCRIPTION
1	Full Scale Attenuator (Channel 1) (S-101)	Sets the Full Scale output of the amplifier in 7 steps from 10 to 1000.
2	Cal-Dir-Avg (S-102)	Direct for normal operation. Average for normal operation. Calibrate to obtain a deflection without a mechanical load change.
3	Bal-ON-OFF (S-103)	BAL - A momentary toggle; it sets and locks the balance signal. ON - for normal operation; it brings the balance and error signals together. OFF - removes only the balance signal from the amplifier. Allows checking Phase Lock.
4	Zero Suppression (Channel 1) +/-X100 switch (S-104)	A 5 position switch: OFF, ±1 x 100 (100% suppression) and ±10x100 (1000% suppression).
5	Vernier (R-102)	A ten-turn adjustable control that can be locked in any position. The dial is graduated into 10 major divisions. For use with item 4.
6	Calibrate (Channels 1 and 2) (R-103)	A 10-turn vernier resistor that sets the overall gain (Gage factor Set .5 to 10.5.)
7	Sensitivity (Channel 1) (R-104)	A lockable variable resistor that sets the gain of Channel 1 only. Provides a 2.5:1 Signal Change from X1.
8	Trim Calibrate Resistor (R-101)	This resistor is placed in series with "Cal R" so that a small amount of correction can be adjusted when using the Cal. switch.
9	Bal Indicator (DS-102)	Green light is ON during the balancing of the amplifier. When "Bal" switch is activated.
10	Phase Indicator (DS-101)	Red light goes on when the excitation to signal, phase shift exceeds ±45° or ±90° as a function of the internal switch S3B.



bi 2682

FIGURE 3-1 FRONT PANEL CONTROLS

3.3 INTERNAL CONTROLS

Item number listed below refer to those in Figure 3-2.

ITEM	CONTROL	DESCRIPTION
R-5	Gain Control Channel 2.	Adjustment to set the gain of Channel 2.
R-6	Zero Control Channel 1.	Zero adjustment for Channel 1.
R-7	Phase Zero.	Zero adjustment for the Phase amplifier.
R-8	X10 Zero Suppression.	Calibration adjustment for the X10 suppression circuit.
R-9	X1 Zero Suppression.	Calibration adjustment for the X1 suppression circuit.
R-10	Negative Zero Suppression	Once the positive suppression is adjusted the negative component is brought in with this control.
R-11	Quad Zero.	Quadrature amplifier zero adjustment.
R-13	Phase Balance	Balance control of the phase amplifier.
R-14	Quad Balance	Balance control of the quadrature amplifier.
R-15	Slave Phase	Phase control of the Slave amplifier. Used to produce 2.5KHz signal for the bridge.
R-16	Excitation Span.	Adjusts the output of the oscillator.
R-17	Slave Balance.	Balances the ripple component of the power supply for U-1 against the oscillator output to the transducer.
R-82	Slave Zero.	Balances U42 Slave Amplifier to zero.
R-84	Input X100 CMR	CMR adjustment in the X100 position.
R-85	Input X100 Gain.	Gain adjustment of the input amplifier in the X100 position.
R-88	Input X1 CMR	CMR adjustment or balance of the first stage amplifier in the X1 position.
R-89	Gain Control Channel 1.	Sets the gain of Channel 1 to its proper level.
S-1	Input Attenuator X1-X100.	This switch multiplies the input by 100 so instead of 10 to 1000 FS we would have 1000 to 100K.
S-2A	Channel 2 Gain X1-X10	This switch multiplies Channel 2 only by a factor of 10.

3.3 INTERNAL CONTROLS (continued)

ITEM	CONTROL	DESCRIPTION
S-2B	Channel 2 Dir-Avg. Filter	By this switch you can operate Channel 2 in Dir or Avg mode independent of Channel 1. Channel 2 goes to Dir. regardless when the Cal-Dir-Avg is switched to Cal.
S-3A	Excitation Norm-Rev. Phase	Just as the name implies, this switch reverses the phase of the oscillator.
S-3B	Excitation 0 Degree - 90 Degree Phase . .	Normal operation would be 0 Degrees with resistive type Transducers. For other configurations a Phase shift may be necessary and is available.

3.4 PLUG-IN COMPONENT TERMINALS

Item numbers listed below refer to those on Figure 3-2.

ITEM	DESCRIPTION
R1-R2-R3	Bridge completion.
Cal R. (R-4)	Bridge Shunt Calibration.
Jumper E1-E2 Normal	Calibration polarity reversal.
Jumper E2-E3 Reverse	(Reverses calibration only).
Jumper E4-E5 Master	Synchronization: One unit must be master, all
Jumper E5-E6 Slave	others should be slave.
Bal R. (R-25)	Balance Resistor normally set for +/-10mV offset (18Kohms).
C6-C7 (Ch. 1)	Filter Capacitors
C10-C11 (Ch. 2)	(May be changed to other than 12dB/octave roll-off.)

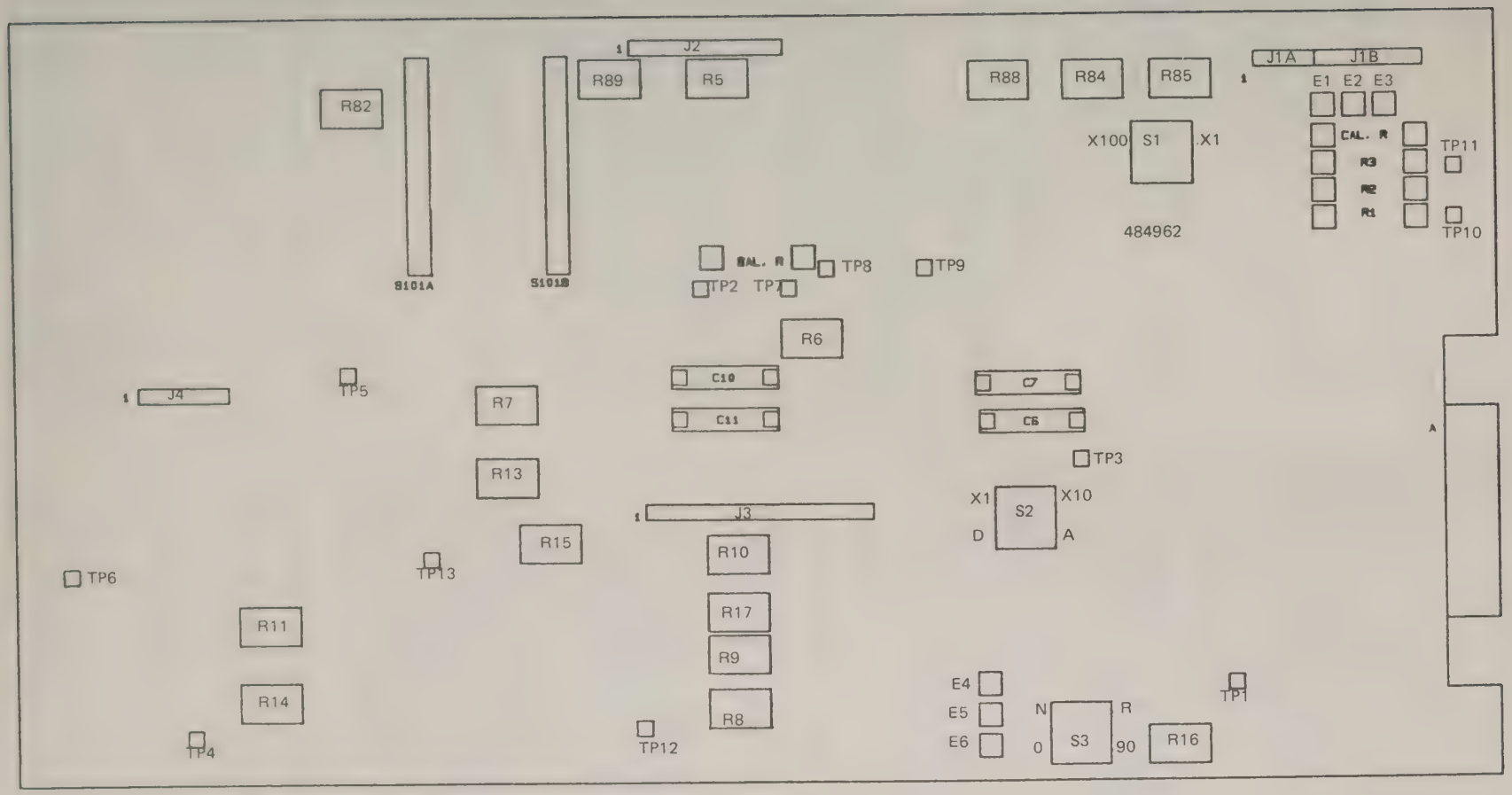


FIGURE 3-2 INTERNAL CONTROLS

3.5 BRIDGE CALIBRATION

After completing installation and setup instructions in Section II, the unit may now be calibrated. Three methods of calibration are used and are described below:

1. Known calibration resistance (a given resistance equals a given mount of mmHg, microinches per inch, lbs/sq. inch, etc.).

2. Transducer loading.

3. Calculating calibration resistance.

All three methods will be described in detail. User must determine most convenient method.

NOTE: If your bridge includes a "Shunt R" for calibration, just place a jumper in the "Cal R" spot in the following steps.

1. Known Calibration Resistance

a) Install transducer.

b) If calibration resistance is known, simply insert correct calibration resistor where marked "CAL R", and, if necessary, adjust the front panel trim control for exact resistance reading. (Internal Cal Resistor and the front panel trim control are additive. Part 3 below tells how to measure.)

c) Turn "Full Scale" switch to 1000 and switch the "Bal-On-Off" switch to "Bal" momentarily. This balances the Bridge.

d) With resistance controls properly set, push "Cal-Dir-Avg" switch to "Cal" position.

e) Advance "Full Scale" control clockwise until desired Full Scale setting is reached.

f) Now adjust "Calibrate" control to place pen on desired chart division.

g) Return "Cal" switch to "Dir".

EXAMPLE: For given transducer, 430K ohms equal 50mmHg. Install transducer and 430K ohm R CAL resistor. Turn the "Full Scale" switch to 1000 and switch the "Bal-On-Off" switch to "Bal" momentarily. This balances the bridge. Turn "Cal-Dir-Avg" switch to "Cal" position. Advance "Full Scale" to 100 position. Adjust "Calibrate" control to 50% F.S. (25 divisions). Return toggle switch to "Dir" position. Each division on recorder chart now represents 2mmHg.

2. Transducer Loading

a) If calibration resistance is unknown, it will be necessary to establish a known load or deflection at the transducer. Balance transducer per Section 2.6 and apply a known load.

b) Advance "Full Scale" to desired full scale setting.

c) Now adjust "Calibrate" control to place pen on desired chart division and lock control.

d) Establish no-load condition at transducer.

e) Set toggle switch to "Cal" position.

f) Adjust internal CAL R and front panel "Trim" control until same pen deflection is achieved.

g) Record dial settings versus load or deflection and transducer number for future calibration reference. Also note total resistance. (Cal R and "Trim" are in series in the "Cal" position. Part 3 below tells how to measure.)

EXAMPLE: For a typical transducer, apply a pressure of 100mmHg. Rotate "Full Scale" to 250 position. Adjust "Calibrate" control to set pen to 40% F.S. (20 division - 2VDC output). Each chart division now represents 5mmHg. Vent transducer to air and push toggle switch to "Cal" position. Adjust value of CAL R and front panel "Trim" control until same output is achieved. Note total resistance.

3. Calculating Calibration Resistance

The proper calibration resistance (R_{cal}) can also be calculated using the following equation:

$$R_{cal} = R \left[\left(\frac{10^6}{4FN}\right)\right] - 0.5$$

where:

R_{cal} = calibration resistance in ohms

N = desired calibration pressure in cmHg

R = output resistance of transducer in ohms

F = transducer calibration factor in microvolts (open circuit) per volt (excitation) per cmHg.

EXAMPLE: Determine the calibration resistance necessary to calibrate a Statham P23 DB for 10 cmHg when given.

R = 316.4 ohms

F = 54.38 uv/v/cmHg

$$R_{cal} = 316.4 \left[\left(\frac{10^6}{(4)(54.38)(10)}\right)\right] - 0.5$$

$$= (316.4)\ (459.728 - 0.5)$$

$$= 145.3K \text{ ohms}$$

The calculated value is obtained by inserting a 1/4% resistor which is between the calculated value, and the calculated value minus 5K ohms. The front panel "Trim" control is then adjusted until the desired resistance is achieved measuring across E1 and E3 with a precision ohmmeter. CAL R and the TRIM pot are in series and the TRIM pot has a max R of 10K ohms.

3.6 OPERATION

Install the amplifier in its frame and properly lock it in place.

Turn the power on for warm up, approximately 15 minutes.

Connect the transducer to the input connector.

Turn the "Full Scale" control to Off and the "Bal-On-Off" switch to Off.

Calibrate control to 1.0 (unless otherwise determined). Sensitivity to X1-detent.

Zero suppression Off. "Cal-Dir-Avg" to "Dir".

Turn on the chart drive and set pen position to chart center.

Switch "Bal-On-Off" to On.

Switch "Full Scale" to 1000. Now switch "Bal-On-Off" momentarily to "Bal".

When the green and red lights go off, your unit is in balance. You may advance the F.S. switch to a more appropriate sensitivity level. Your unit can now be "Cal"ed as in Par. 3.5 and you will then be ready for operating.

3.7 USING ZERO SUPPRESSION

Zero suppression permits the steady-state component of a complex signal (load) to be suppressed allowing the dynamic portion to be amplified and recorded in greater detail.

a. Set up the bridge as described in paragraph 3.5.

b. Turn Zero Suppression "Vernier" to 1.00 (1 turn CW from full counterclockwise position).

c. Apply a load to the strain gage and rotate the "Full Scale" control until the pen approaches chart edge.

d. Set the "Zero Suppression" (item 4) control to the appropriate range and polarity. Pen should move back toward zero.

e. Advance Zero Suppression "Vernier" dial clockwise until pen approaches chart zero.

f. Advance "Full Scale" control clockwise until desired sensitivity is reached, keeping pen to chart zero with Zero Suppression "Vernier".

g. The load now may be varied around the static portion to obtain more useful information.

3.8 OUTPUT - CHANNEL 2

Channel 2 was primarily designed to provide a signal for digital display and operates regardless of the position of the attenuator. Its full scale output is 0 to 10 VDC and is located at pin J on the XA-201 output strip. With the use of switch S-2A (internal) you can change the sensitivity of channel 2 by a factor of 10. With 1mVRMS input, the output will be 1 VDC in the x1 position, or 10 VDC in the x10 position. With switch S-2B you can change the output from direct (D) to average (A) DC display.

3.9 FUNCTIONAL TEST PROCEDURE

This procedure should be performed to verify operation and calibration of the unit. If calibration is required, refer to Section V of this manual.

1. Connect two, 350 ohm resistors to the input connector as shown in Figure 3-3, below. Monitor channel 1 output (XA201-2) with a DVM.

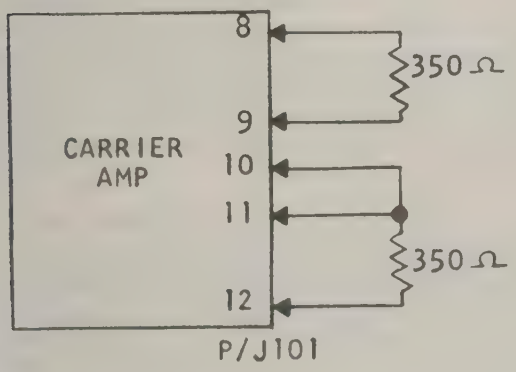


FIGURE 3-3 TEST INPUT CIRCUIT

2. Set the "Calibrate" control, R103, fully CW and the "Full Scale" switch, S101, to 1000. Set the "Sensitivity" control, R104, fully CW to the x1 position.

3. Set the "Zero Suppression" switch, S104, to +10 and adjust the Zero Suppression "Vernier", R102, for a reading of -4.5 ±.001 VDC on the DVM and lock it. Turn the "Zero Suppression" switch, S104, through its various positions. The output on channel 1 should be as shown below.

Zero Suppression Switch	Channel 1 Output (VDC)
+10	-4.5 ± .001
+1	-.45 ± .010
OFF	0 ± .010
-1	+.45± .010
-10	+4.5 ± .010

4. With the "Zero Suppression" switch, S104, set to -10, adjust the "Zero Suppression" control, R102, as shown below and read channel 1 output to check for linearity.

Zero Suppression Switch	Channel 1 Output (VDC)
10.00	+5.0 ± .0075
8.00	+4.0 ± .025
6.00	+3.0 ± .025
4.00	+2.0 ± .025
2.00	+1.0 ± .025
0.00	0.0 ± .025

5. Adjust the "Zero Suppression" control, R104, for a 2.5 ±.001 VDC reading on the DVM and then change the "Full Scale" switch, S101, to 500. The output on the DVM should change to 5.0 ±.02 VDC.

6. Repeat Step 5 for the other "Full Scale" switch settings, adjusting the "Zero Suppression" switch and "Vernier" as shown below. The output should be 5.0 ±.02 VDC after switching to the next lower range.

Full Scale Sw. (Before)	Suppression Sw.	Output Set (Before)	Full Scale Sw. (After)
1000	-10	2.5±.001	500
500	-10	2.5±.001	250
250	-10	2.0±.001	100
100	-1	2.5±.001	50
50	-1	2.5±.001	25
25	-1	2.0±.001	10

7. Remove input network and DVM.

SECTION IV

THEORY OF OPERATION

4.1 AMPLIFIER

The Carrier Amplifier, 13-4615-35 is designed for conditioning low level signals from carrier-excited transducers such as strain gages, variable differential transformers, or reluctance type transducers. The amplifier supplies its own adjustable 2 to 10 volt RMS, 2.5 KHz signal for transducer excitation. Provision has been made internally for bridge completion resistors. A major feature of this amplifier is its automatic balance, and phase control on command. The amplifier has 2 separate outputs. Channel 2 provides 0 to 10 VDC output with a variable gain of from 10 to 1000. Channel 1 has an output of 0 to 5 VDC with zero suppression and a variable gain of 4 to 10,000. Both channels have direct output with 200 Hz filtering or averaging output with .05 Hz filter (12 dB/octave roll-off).

4.2 REFERENCE

In the following discussion on the Carrier Amplifier please refer to the Schematic (294952), the front panel controls (found in the rear of the manual), and Figures 4-1 and 4-2 in this chapter. Figure 4-1 shows an amplifier configuration which is used to perform various functions in the carrier amplifier. An understanding of this basic circuit is necessary. Figure 4-2 shows the 8 major building blocks that make up automatic balance Carrier Amplifier.

4.3 BASIC CARRIER DESIGN

The circuit in Figure 4-1 is used to show the performance of various functions in the carrier amplifier. An understanding of these basics helps in the overall view and operation of this amplifier. Therefore, the following formula and information is given.

With the switch closed to ground, it can be shown that:

$$eo = \left[1-\left(\frac{Z1+Z2}{Z2}-1\right)\frac{Z4}{Z3}+\frac{Z4}{Z5}\right] \quad \frac{Z2}{Z1+Z2}\ ein$$

If $Z1 = Z2 = Z3 = R$, $Z4 = 11R$ and $Z5 = \frac{11}{20}R$

$$eo = \left[1-\left(\frac{R+R}{R}-1\right)\frac{11R}{R}+\frac{11R}{\frac{11}{20}R}\right] \quad \frac{R}{2R}ein = +5\ ein$$

If the switch is opened $Z5 \text{ ——— } \infty$

$$eo_R = \left[1-\left(\frac{R+R}{R}-1\right)\frac{11R}{2R}\right] \quad \frac{R}{2R}ein = -5\ ein$$

This is an inverting or non-inverting amplifier with a gain of 5 depending on the position of the switch and the values of the resistors.

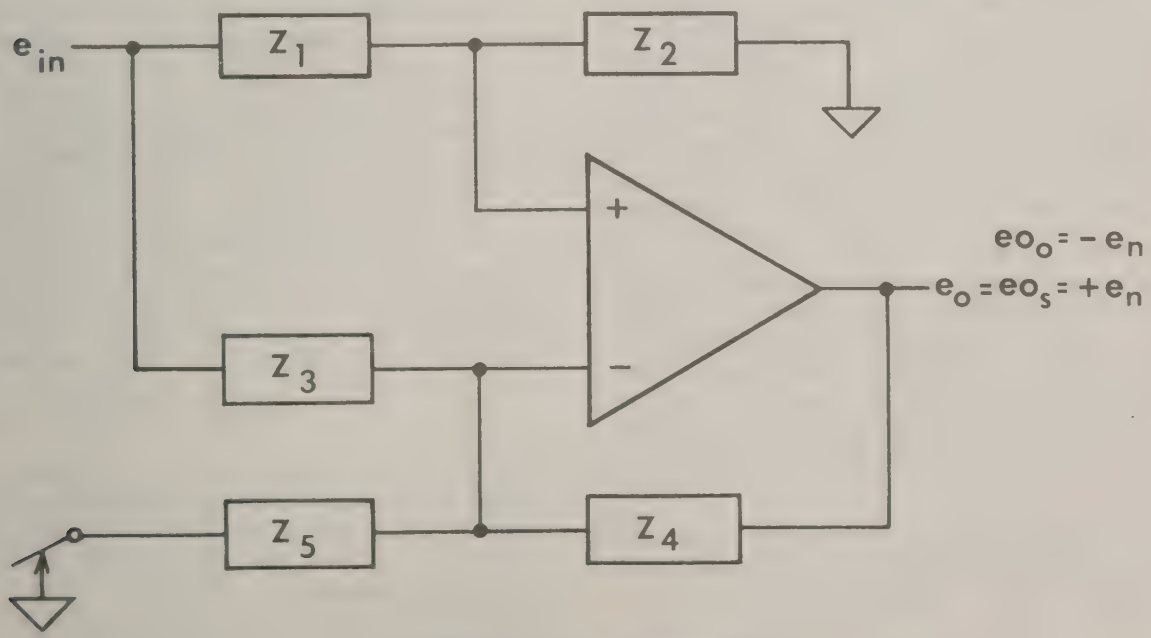


FIGURE 4-1 BASIC CIRCUIT

By changing the resistance ratios any positive or negative gain can be achieved subject to the limitations of the operational amplifier and resistors. If desired, R-5 could be made adjustable to insure + and - gains of equal amplitude.

A switching transistor or FET could be used instead of a switch. However, ON-OFF impedances must be compatible with the resistor values chosen. With a reference driver voltage this configuration could be used as a modulator or demodulator.

If an FET is used in its linear resistance range, a variable gain amplifier results with a gain variation from +K through zero to -K, where K is a function of the FET resistance and resistor components. This configuration can be used as an automatic gain control.

If R4 is replaced by a capacitor and R5 is the right value, an inverting amplifier will result, which could be used as a ramp generator in a voltage controlled oscillator.

4.4 MASTER OSCILLATOR

Use Figure 4-2, Block diagram plus the schematic to locate an area of discussion.

The master oscillator consists of Q12, U18-4, U21-1, -2 and -4 and their associated components. This type of oscillator is known as a quadrature oscillator because of its two outputs. One is termed sine or phase output and the other is cosine or Quad output. U18-4, U21-1 and their associated components constitute the automatic gain control which maintains a constant sine wave output at U21-2. The cosine output is at U21-4. The oscillator output frequency is at 2.5 KHz and the amplitude is 5.554 volts RMS. By removing the sync-link and driving pin 6 of XA-201 (output connector) from another master oscillator, synchronization of both amplifiers can be accomplished.

4.5 EXCITATION DRIVE

Transformer T-3, U21-3 and Q13 thru 16 with their associated components make up the excitation amplifier that drives the transducer. A stable class A-B amplifier is formed by Q13 thru 16, and is driven by U21-3. The above combination provides an inverting or non-inverting amplifier with a gain of +/- 2.3, as described in Figure 4-1. Transformer T3 provides a floating excitation source. The excitation can be varied from 2 to 10 volts RMS into a .29 watt load by adjusting R-16. Using switch S3-B, the phase of the excitation, with reference to the master oscillator, can be switched to 0 or 90 degrees.

4.6 PREAMPLIFIER

The incoming transducer signal may have a phase shift with respect to its excitation voltage. If there is 0 degrees phase difference then the error signal can be expressed as Ex Sin $2\pi f+\alpha$. Where Ex is the amplitude modulation proportional to the physical parameter being monitored by the transducer, f is the Master oscillator frequency and α the transducer phase shift.

The signal is connected to the floating differential input at the preamplifier consisting of U1-1, -3 and -4 and U4-3 with their associated components plus transformer T1. Provision has been made for bridge completion resistors "R1", "R2" and "R3" along with a "Cal" resistor and a cal resistance "Trim" resistor R101, mounted on the front panel. A jumper is provided from E2 to E1 for normal positive deflection, or E2 to E3 for negative deflection.

A 100 to 1 signal attenuator is made of resistors R18 thru R23. The amplifier has a gain of 10 and a maximum output at T1 of 100 mV. The power for the preamplifier is obtained from the 2.5 KHz oscillator through Q17 and 18 output drivers and into T2. The output is rectified by CR15. Because of the frequency very little filtering is necessary. The signal from the transformer T1 is further amplified by U4-3 and its associated components. Its gain is 2.5 to 25 and adjusted by the calibration control on the front panel.

Unwanted signals from the transducer are not rare. They are electrical and mechanical off-zero signals which may be present due to pickup or a non-ideal transducer. Provision is made to balance these unwanted signals automatically to zero at the input of U4-3. The "Bal R" resistor is used to adjust the gain of U4-3, or overall, the auto balance voltages.

When an 18 K ohm resistor is used as Bal R, it will allow balancing a 10 mV input signal. The formula for computing the value of the Bal R resistor is:

$$R\ (Bal) = \frac{45.54\ ein}{.036 - ein}\ K\ ohms$$

4.7 CHANNEL 1

Channel 1 consists of the attenuator S-101, U4-1 and -2, U8-1, -2 and -4, U10-2 and all their associated components. The output, 0 to 5 volts, is designed to be compatible with the 2000 Series Recorder. The gain in the most sensitive attenuator position is about 200.

The preamplifier output signal and the zero suppression signal is summed at the input of U4-2. Its output is applied to the attenuator through the sensitivity control R104. The control is accessible on the front panel and has a variation of from .4 to 1. The attenuator is also on the front panel and has 8 positions; 10, 25, 50, 100, 250, 500, 1000 units and OFF. In the OFF position both channels 1 and 2 are disconnected from the input and grounded. In addition U4-1 is also grounded in the OFF position. This disables the zero suppression circuit and returns it to zero. The output of U4-1 is capacity coupled to U8-2, the phase demodulator. The demodulator has a gain of +/-1, and its reference signal is from the slave sine oscillator. Refer to Figure 4-1 for demodulator operation. The gain has increased by 2 at the output U8-2. The signal then is sent to U8-1, the direct filter. From the direct filter the signal goes to U8-4, the average filter. With the Cal-Dir-Avg Switch, S102, you can choose either direct or average filter output to be sent to the recorder through buffer amplifier U10-2. Direct filter output only is displayed in the Cal. position.

4.8 CHANNEL 2

Channel 2 consists of U4-4, U6-1, -2, -4, U10-1, and their associated components. Its Full Scale output is 10 VDC and is intended for use as an output to a digital display device. This channel also is used to control the auto phase and auto balance circuits. The gain is fixed at 4 between the preamplifier and the filter outputs. An internal switch is used to choose either direct or average filter. Also, an internal switch lets you choose X1 or X10 gain for U10-1. The input amplifier, U4-4 amplifies the incoming signal by 2 and capacity couples it to the demodulator U6-2 and the auto phase and the auto balance circuits. The demodulator has a gain of +/-1 and uses the same reference voltage as channel 1. A close similarity exists between the demodulator, the direct, and the average filters at both channels 1 and 2. The channel 2 direct filter output is also used in the auto phase and auto balance circuits. U6-1 and -4 are the direct and average filters for channel 2.

4.9 AUTO PHASE

The Auto Phase consists of transistors Q4, 9, 10, 11 and IC chips U12-3, -4, U15-1, -2, -3, -4, U18-1, -2, U6-3, U8-3 and their associated components. If the transducer has a phase shift, as outlined in the preamplifer section, and the signal is amplified and demodulated with a reference voltage, which is in phase with the excitation, an error will result. This would show up as an output, at the filters, as KEx Cos $\propto$ instead of just KEx. The purpose of the auto phase control is to eliminate this error. If the signal is demodulated with a quadrature reference voltage, that is one that is 90 degrees out of phase with the transducer excitation, the output would be KEx Sin $\propto$. If a servo loop is set up to shift the quadrature reference voltage to E(ref) Cos ($2\pi f\propto$), the phase difference between the input and Quad reference signal will be exactly 90 degrees and the demodulator output would be zero. If at the same time a phase reference voltage E(ref) Sin ($2\pi f+\propto$) is developed and used as the reference to the channel demodulators, the output to the channel filters will be KEx and independent of the phase shift.

The slave Quadrature Oscillator, similar to the master oscillator in sync mode, uses U15-3, -4, U18-1, -2, Q9 and their associated components. The output of U15-4 is the slave phase, or the sine voltage reference. The Quad or Cosine reference is the output of U18-1. Constant amplitude is held at the sine output of U15-4 by U15-3 and U18-2. The sum of the Master Sine Output and the output signal from U15-2 constitute the sync signal for the Slave Oscillator. A variable gain amplifier with +/-1 on the output, as described in Figure 4-1, uses U15-2 and Q11. The master cosine output furnishes the input to this amplifier (U15-2). The summation of the master sine, and the output of U15-2 produces a sync signal for the Slave Quadrature Oscillator which can be varied in phase from 0 to +/-60 degrees, in reference with the master sine, depending on the DC voltage controlling FET Q11.

U12-3 and Q10 constitute a demodulator using the slave cosine signal as its reference voltage. The input signal to U12-3 is KEx Sin $2\pi f+\propto$ from the output of channel 2 (U4-4) + a small signal from the master sine. The output of the demodulator, KEx Sin $\propto$, is fed to the integrating filters U15-1, whose output controls the DC level of the FET Q11. This shifts the phase of the sync signal, resulting in a phase change in the slave oscillator. The output of the integrating filter holds a fixed

DC level when the DC output of the demodulator is zero. This occurs when the slave oscillators phase is equal to the signals phase. The reference voltage for channel 1 and 2 demodulators is from the sine output of the slave oscillator, (E(ref) Sin $2\pi f+\propto$). This results in phase demodulation of the amplified transducer signal independent of phase. If the amplitude of the signal Ex = 0, the small 50 mV signal from the master oscillator locks the slave phase shift to zero. The circuit is limited to signal phase shifts that lie between +60 and -60 degrees. If the transducer has an additional 180 degree shift, this condition is detected by U24-3, and the gain of U12-4 is reversed. This automatically corrects for the 180 degree shift. If the signal phase shift is 90 $+\propto$, U8-3 will turn the phase indicator DS-101, on the front panel, on. U8-3 is set to detect any phase greater than 50 degrees. When this indicator (DS-101) is on, there is a possibility of a phase error existing. Therefore, the internal 0 - 90 degree switch should be moved to its alternate position.

Since the slave oscillator sine output voltage is always constant and in phase with the amplified transducer signal, the sine output can also be used as a calibrated zero suppression signal in channel 1 without effecting the phase relationships of the control loop in channel 2. The zero suppression control and switch on the front panel, and U18-3 with its associated components on the PC board, set the required levels for zero suppression, to be added to channel 1 at U4-2. U18-3 is an inverting or non-inverting amplifier with equal gain, (see Figure 4-1), and allows either + or - zero suppression to be obtained.

4.10 AUTO BALANCE

The auto balance circuit consists of: Q3, 5, 6, 7, 8, U12-1, -2, U24-1, -2, -3, -4, U27-1, -2, -3, -4, U30-1, -2, -3, -4, -5, U31-1, -2, U32 thru 39 plus associated components, and is controlled from the front panel by the balance switch. If the transducer contains any noise in its output, a non-linearity or saturation may result in the carrier outputs. If the transducer noise is not of the carrier frequency it must be reduced to a negligible amount at the transducer. If the noise is of the carrier frequency, the auto balance circuit can be used to reduce it.

A momentary actuation of the balance switch (S102), on the front panel, will activate the auto balance. The action is as follows: U30-4 is turned off which turns on U30-5. U30-5 is capacity coupled back to the input of U30-4. This in turn holds U30-4 off and U30-5 on for approximately one second. In the on condition U30-5 enables the counters U32 thru 37, and also the quad and phase voltage controlled oscillators (U27-1, U24-1). It also turns on the balance indicator (DS-102) on the front panel. This sequence can also be initiated, when the balance switch (S103) is in the on position, by grounding XA201-C on the output connector using TTL logic or switch closure. This effectively turns off U30-4 for 1 millisecond to start the time out.

The signal from channel 2 (U4-4) is demodulated by U12-2 using a reference voltage developed by the master cosine (Quad) output. As a result, the filtered output of U12-1 is proportional to the Quad component of the signal. This DC voltage is fed to the Quad VCO, U27-4 and to the comparator U27-3. A positive input to the comparator sets the up/down counters, U32 to 34, to count down and sets U27-2 to a gain of +1. With a negative input the counters are set to count up and the gain of U27-2 is set at -1. The Quad VCO is made up of Q7, U27-1, -2 and -4. U27-4 and its associated components make up a ramp generator, as described in Figure 4-1. With the auto balance in the OFF position and a DC signal at the input, both 27-1 and -4 will have positive outputs regardless of input polarity. When the auto balance is initiated U27-4 ramps between + and -4 volts, at a repetition rate of about 7000 Hz/volt and the counters will count up or down depending on the input DC level. The Quad D/A uses the Quad output as its reference and the counter output as its input. The output signal at U31-2 can vary from 0 to -5.554 cos $2\pi f$. This signal is attenuated and summed with the Quad output to produce a signal which varies from .14 Cos $2\pi f$ through zero to -.14 Cos $2\pi f$, across an 18 K ohm R Balance resistor when the Balance Switch is in the ON or Bal. positions. This signal is summed with the transducer signal at the input of U4-3. From the output of U4-3 we raise the level and demodulate it, then on through the Filter output U12-1. This loop constitutes a servo which during balance develops a signal, to null the Quad component of the transducer signal to zero.

The phase loop for nulling the phase component of the transducer signal consists of U24, U35 to 37, U39 and U31-1 and their associated components. The demodulator and filter, in this case is U6-1 and

-2 of channel 2. At balance there will be no output signals from the filters and the slave sine phase will be the same as the master sine.

When the zero balance switch (S103) is moved momentarily to its balance position it automatically returns to the ON position. The control circuit triggers a 1 second delay in which both VCO's are disabled, the balance indicator is turned off, and the counters are locked at their last reading. With an R Balance resistor of 18 K ohms, the maximum input signal that can be balanced will be 10 millivolts. If the signal is larger than this span the channel outputs will go to zero and discontinuity may occur. The minimum recommended span is 1 mV, (with proper resistor substituted for R Balance) referred to the input, because the balancing time increases with decreased span.

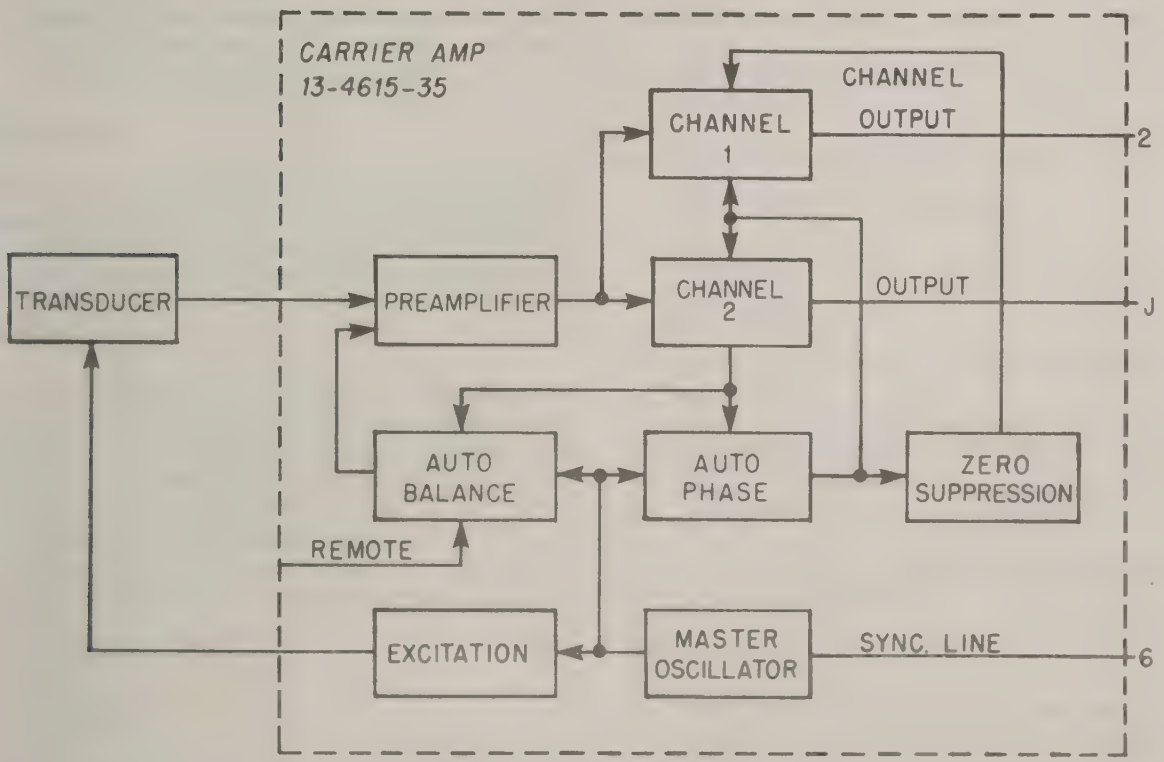


FIGURE 4-2 BLOCK DIAGRAM

SECTION V

MAINTENANCE AND CALIBRATION

5.1 MAINTENANCE

Maintenance on the preamplifier is limited to cleaning only.

CAUTION:

1. **Before attempting to clean preamplifier, turn OFF power and remove from enclosure.**

2. **Avoid use of chemical cleaning agents which might damage plastic or printed surfaces. Do not use chemicals which contain toluene, Cellusolve, acetone or similar solvents.**

EXTERIOR

Remove loose dust with a soft cloth or small paint brush. Dirt which remains can be removed with a soft cloth dampened in a mild detergent and water solution. DO NOT USE ABRASIVE CLEANERS.

INTERIOR

Dust in the interior should be removed occasionally due to its electrical conductivity under high humidity conditions. Blow off accumulated dust with dry low pressure air. Remove any dirt which remains with a soft paint brush or a soft cloth dampened in a mild detergent and water solution. A cotton-tipped applicator is useful for cleaning in narrow spaces and/or printed circuit boards.

5.2 CALIBRATION

5.2.1 General

The Gould Carrier Amplifier, Model 13-4615-35, has been accurately calibrated before shipment from the factory and should give long troublefree service. Should recalibration be required, it should be performed by qualified technical personnel only.

CAUTION: CALIBRATION SHOULD NOT BE ATTEMPTED UNLESS SUITABLE, SPECIFIED TEST EQUIPMENT IS USED. SINCE SPECIAL, HIGH PRECISION EQUIPMENT IS REQUIRED, IT IS RECOMMENDED THAT THIS MODEL BE RETURNED TO THE FACTORY FOR RECALIBRATION.

NOTE: Under normal conditions, complete calibration should be performed every 6 months. After repair of the unit or some other change in the electronics, it is necessary only to recalibrate those circuits affected by the change.

5.2.2 Equipment Required

The following is a list of test equipment necessary for calibration.

a. Dual Trace Oscilloscope - Tektronix or equivalent.

b. Digital Voltmeter - Fluke 8300 or equivalent.

c. AC Calibrator - Fluke 5200A.

d. Leakage Tester - Slaughter 103/105 or equivalent.

e. Gould Recorder - Gould 2000 Series or equivalent.

f. Distortion Analyzer - HP330B or equivalent.

g. Frequency Counter - HP5302A or equivalent.

h. Decade Voltage Divider - General Radio Type 1454A or Equivalent.

5.2.3 Preliminary Procedure

a. The internal controls will be set during calibration. Set the front panel controls as follows:

1. Full Scale Attenuator (S101) . . . . . OFF
2. DIR/AVG/CAL Switch (S102) . . . . . DIRECT
3. Bal-On-Off Switch (S103) . . . . . OFF
4. Suppression Switch (S104) . . . . . OFF
5. Trim Control (R101). . . . . doesn't matter
6. Suppression Vernier (R102) . . . . . Fully CCW
7. Calibration Control (R103). . . . . Full CW
8. Sensitivity Control (R104) . . . . . CW to X1

5.2.4 Calibration Procedure

Set-up:

Turn power OFF
Remove Slave Link E4-E5 (Save)
Follow Figure 5-1. Install leads-
Osc. to E5. All grounds common to preamplifier frame.
Set Oscillator to 2.5 KHz approximately 14 V p-p
Channel 1 of Scope to E5 (ref.)
Channel 2 of Scope to TP1
Turn power on - Warm-up 15 minutes, superimpose waveforms W-1 (see Fig. 5-3)
Readjust Oscillator if necessary for a match (Freq. & amplitude).
Set variable resistor (10 Kohm) for 1.00V Input to Divider.

Switch S-3 Test (Phase and Reverse)

N-R Switch	0-90 Switch	Waveform (see Figure 5-3)
N	0	W-1
R	0	W-2
N	90	W-3

Now proceed through the entire calibration table that follows, in sequence.

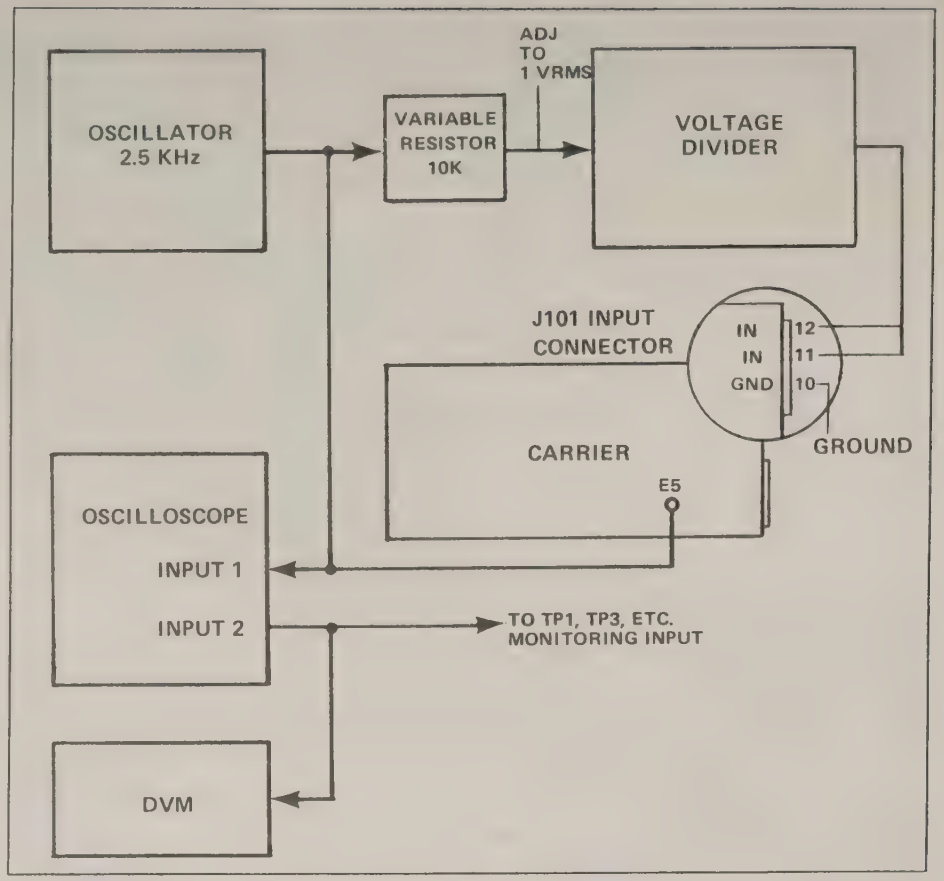


FIGURE 5-1 TEST SET-UP

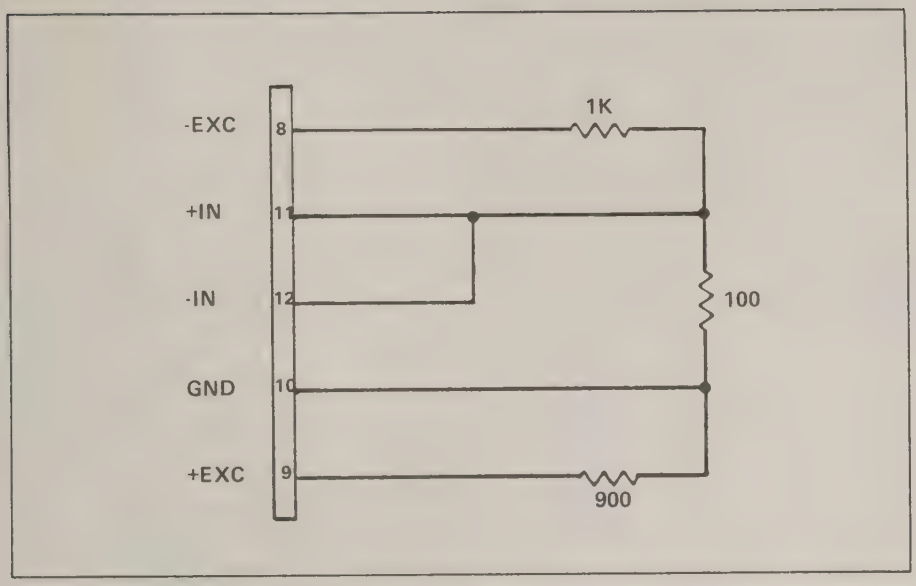
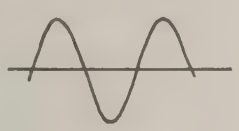


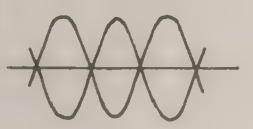
FIGURE 5-2 COMMON MODE TEST FIXTURE

Scope Waveforms

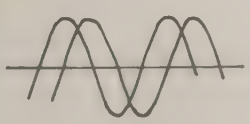
W-1



W-2



W-3



W-4

Scope Settings

For W-1, -2, & -3:

Volts/Div.: 2
Sweep: 50 us.

Set-up for W-4:

Turn Volts/Div. Sw. to 0.5 (both channels). Turn Sweep, Time/Div. to 10 us. Adjust Horizontal position so that the trace crosses near the center of the screen. Adjust R-15 so that both traces cross the center line together within ±.5 us.(Slave Phase Test.)

FIGURE 5-3 OSCILLOSCOPE WAVEFORMS

5.2.4 Calibration Procedure (continued)

Remarks	Note:	TP	Adj. R	Output V	Tol (±mV)
Excitation Span:					
Make sure Norm-Rev Sw. is on Norm and 0 to 90 Deg. Sw is on 0. Install 350 ohm load across input connector pins 8-9	DVM (AC)	10-11*	16	5 VRMS	20
Slave Phase					
Superimpose waveforms W-4 (Make sure the waveform crosses exactly at zero) (see Fig. 5-3)	Scope	3	15	0 phase	.5us
Phase Zero					
Set S2 as follows: X1-X10 to X1, Dir-Avg. to Dir.	DVM (DC)	2	7	0	1
Slave Zero (Applies only to S/N below 385.)					
Rotate Adj. R CW to 15. Rotate Adj R. CCW to (DC Zero)	Scope (5V)	13 (may be on small board)	82 (may be on small board)	15 0	1
NOTE: Oscillation around 0. Leave set at 0.					
Quad Zero					
Balance to Zero	DVM (DC)	4	11	0	1
Phase Bal.					
Rotate CW to 14.5. Very slowly rotate CCW to -12.5 & leave.	Scope (5V)	5	13	14.5 -12.5	.5V .5V

*NOTE: AC meter across TP 10 & 11 for this test only.

5.2.4 Calibration Procedure (continued)

Remarks	Note:	TP	Adj. R	Output V	Tol (±mV)
Quad Bal.					
Rotate CW to 14.5. Very slowly rotate CCW to -12.5 & leave.	Scope (5V)	6	14	14.5 -12.5	.5V .5V
Channel 1 Zero					
Balance to Zero. Use output XA201-2 (or U10 pin 7)	DVM (DC)	Channel 1 Output	6	0	1
Input X1 Common Mode (set S1 to X1)					
Replace the input connector only. Use Figure 5-2. FS Switch to 10	Scope AC (1V) DVM (AC)	7	88	Null	---
Input X100 Common Mode					
Switch S1 to X100. Reset Switch S1 to X1	Scope AC (1V) DVM (AC)	7	84	Null	---
Slave Bal.					
F.S. Switch to OFF, Calibrate Control full CW	Scope (500 mV) DVM (AC)	12	17	Null	---
Channel 2 Gain					
Refer to Figure 1 for proper input. Bal-ON-OFF Sw. to OFF, FS Sw to 1000. Input 10mV RMS. Calibrate full CW. Monitor output (XA201-J or U10 pin 1).	DVM (DC)	Channel 2 Output	5	1	1
Turn Cal. Control (R103) so knob reads 1.00. Lock knob.			Adjust R103 knob on shaft, if necessary.	10	50

5.2.4 Calibration Procedure (continued)

Remarks	Note:	TP	Adj. R	Output V	Tol (±mV)
Input X100 Gain					
Switch S1 to X100, input 100 mV (monitor as above). Reset Switch S1 to X1.	DVM (DC)	Channel 2 Output	85	1	5
Output X10 Gain					
Switch S2A to X10. Input to 1 mV (monitor as above).	DVM (DC)	Channel 2 Output	---	10	See Note
NOTE: Output reading should be 10 times the above reading.					
Reset Switch S2A to X1.					
Channel 1 Gain					
FS Sw. to 1000, Switch S1 to X1. Input 10 mV. Use output XA201-2 or U10 pin 7.	DVM (DC)	Channel 1 Output	89	5	5
Zero Supp. +10					
FS Sw. to 1000. Short input pins 11-12. Supp. Sw. to -10. Supp. Vernier to 10. Output as above.	DVM (DC)	Channel 1 Output	8	5	2
Zero Supp. Negative					
Supp. Sw. to +10. Output as above.	DVM (DC)	Channel 1 Output	10	-5	2

5.2.4 Calibration Procedure (continued)

Remarks	Note:	TP	Adj. R	Output V	Tol (±mV)
Zero Supp. +1					
Supp Sw. to -1. FS Sw. to 100.	DVM (DC)	Channel 1	9	5	2
Output as above. Supp. Sw. to +1		Output	---	-5	5

Unit is now ready for operation.
Turn power off.
Remove all leads and connectors.
Replace Sync Link at E4-E5.
Replace covers.

SECTION VI

PARTS IDENTIFICATION

6.1 GENERAL

The Gould Carrier Amplifier, Model 13-4615-35, has been accurately calibrated and adjusted before shipment from the factory, and should give long troublefree service. For servicing beyond the scope of the instructions contained in this manual or the technical equipment available, contact your nearest Gould Service Engineer listed on the warranty card shipped with the amplifier.

The following parts lists, exploded views, and schematic diagrams are designed to assist in servicing and repairing the amplifier. For replacement parts, refer to the appropriate Figure and Parts List that follow. The individual items listed do not necessarily imply that they are a procurable part, as some are for reference purposes only.

Schematic drawings are in the appendix (rear section) of this Manual, in numerical order.

To assure prompt and satisfactory delivery of replacement parts, include the following information with your purchase order:

1. Name and model number of the instrument.
2. Description of part as listed in this manual.
3. Gould part number.

NOTE: Do not use the SYMBOL NUMBER from the parts list for identifying desired parts on the order.

6.2 ATTACHING PARTS

(A-P) indicates that the following parts, up to -- -- -- -- -- * -- -- -- -- --, are Attaching Parts; i.e., unillustrated hardware required to attach the preceding item to the assembly.

EXPLODED VIEW
CARRIER AMPLIFIER, MODEL 13-4615-35
FIGURE 6-1

ITEM NUMBER	PART NUMBER	DESCRIPTION 1 2 3 4 5 6	REMARKS
	13-4615-35	Amplifier Assembly, Carrier	
	686421	Cover Assembly	
1	285943	Cover, Slide	
2	285947	Insulator	
3	685944-1	Frame	
4	894952	Board Assembly, Carrier (see Figure 6-2) (A-P)	
	13-262716-4004	Screw, Pan Head	
		-- -- -- -- -- * -- -- -- -- --	
5	788971	Panel Assembly, Rear (A-P)	
	13-262716-4004	Screw, Pan Head	
		-- -- -- -- -- * -- -- -- -- --	
	796173	Connector Assembly (A-P)	
	31-119918-4004	Screw, Mach.	
	1-216741-411	Lockwasher	
		-- -- -- -- -- * -- -- -- -- -	
6	288926	Connector	J-101
	288932	Contact	
7	287491-7	Connector	P1-B
	1-287490	Contact	
	287489	Key, Polarizing	
	232997-23	Strap, Retaining	
	861810-453	Cable Assembly, 2 Cond. Shld.	
8	285943	Cover, Slide	
	896161	Harness Assembly (A-P)	
	663800-1	Nut, Knurled, Plated	
	1-293279-1	Nut	
		-- -- -- -- -- * -- -- -- -- --	
9	287491-4	Connector	P1-A
	1-287490	Contact, Male	
	287489	Key, Polarizing	
10	287491-10	Connector	P2
	1-287490	Contact, Male	
	287449	Key, Polarizing	
11	287491-15	Connector	P3
	1-287490	Contact, Male	
	287489	Key, Polarizing	
12	287491-6	Connector	P4
	1-287490	Contact, Male	
13	230050-102	Resistor, Variable	R-102
14	295357-203	Resistor, Variable	R-104
15	230050-202	Resistor, Variable	R-103
16	296115-1	Lug, Solder	
17	286151-3	Switch, Rotary	S104
18	287491-2	Connector	P5-6
19	230079	Switch, Toggle	S103
20	291996-1	Switch, Toggle	S102

EXPLODED VIEW
CARRIER AMPLIFIER, MODEL 13-4615-35
FIGURE 6-1 (continued)

ITEM NUMBER	PART NUMBER	DESCRIPTION 1 2 3 4 5 6	REMARKS
21	293098-103	Resistor, Variable	R-101
	861810-451	Cable Assembly, 2 Cond. Shld.	
	861810-452	Cable Assembly, 2 Cond. Shld.	
	232997-32	Strap, Retaining	
22	127915	Spacer, Plate-Coupling	
23	289396	Diode, LED, Red	DS101
24	289397-1	Diode, LED, Green	DS102
		(A-P)	
	295154-1	Adhesive, Liquid	
		-- -- -- -- -- * -- -- -- -- --	
25	396168	Panel, Sub.	
		(A-P)	
	13-262715-4004	Screw	
		-- -- -- -- -- * -- -- -- -- --	
26	796170	Panel Assembly, Silkscreen	
		(A-P)	
	31-119998-26	Nut	
	8-120052-101	Lockwasher	
		-- -- -- -- -- * -- -- -- -- --	
27	694245	Knob Assembly, Locking	
28	285651-16	Knob	
29	285650	Knob, Control	
30	284990	Knob, Turns-Counting	
		(A-P)	
	31-121166-2602	Screw, Set	
	31-121166-2693	Screw, Set	
		-- -- -- -- -- * -- -- -- -- --	
31	285652-1	Knob	
32	285652-2	Knob	

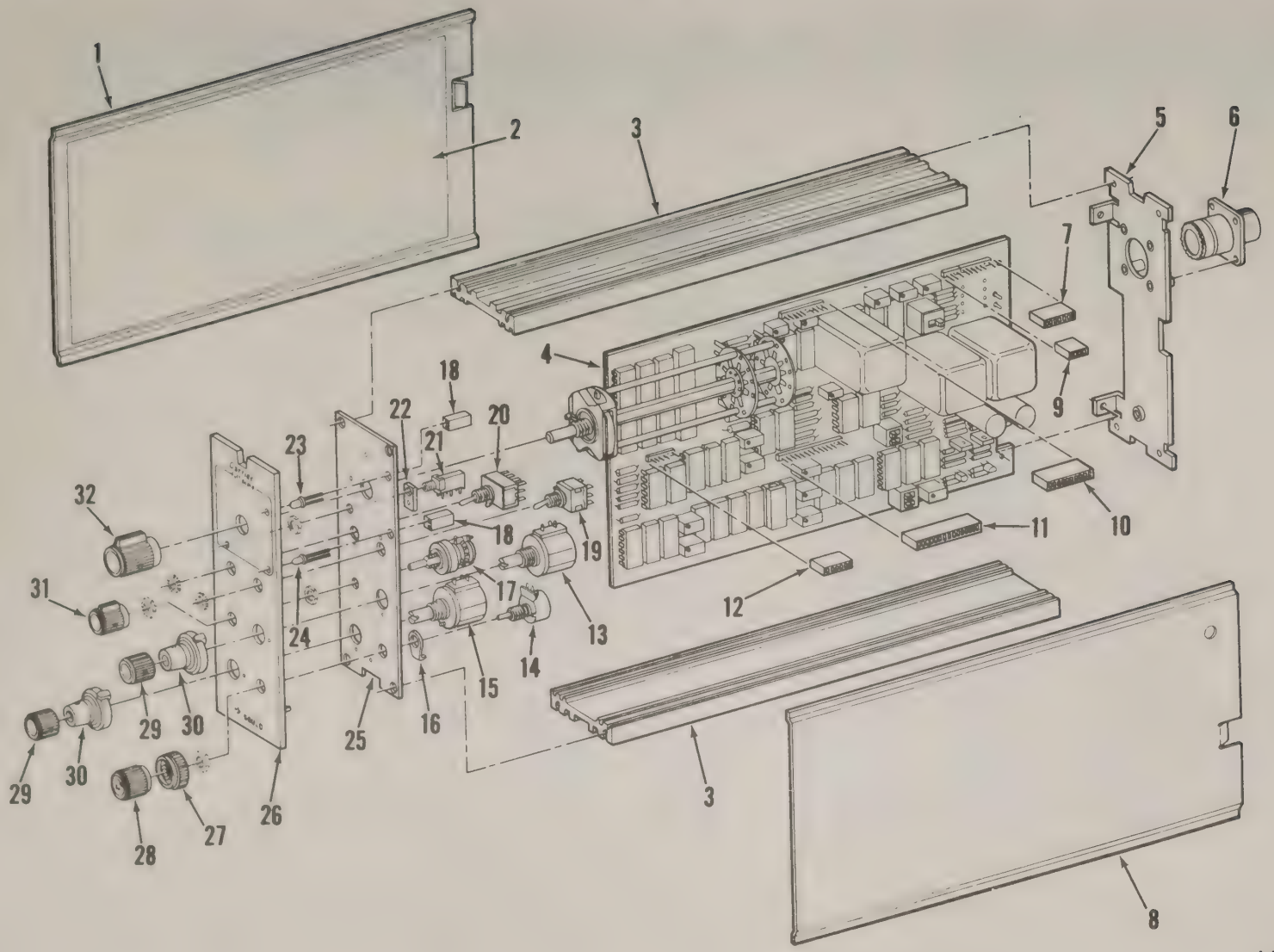


FIGURE 6-1 CARRIER AMPLIFIER, MODEL 13-4615-35

ELECTRICAL PARTS LIST
BOARD ASSEMBLY 894952
FIGURE 6-2

SYMBOL NUMBER	PART NUMBER	DESCRIPTION
C1-C3	288755-104	Capacitor, .1 μfd, Ceramic, 50 WVDC
C4	287614-393	Capacitor, .039 μfd, Ceramic, 50 WVDC
C5	287614-103	Capacitor, .01 μfd, Ceramic, 50 WVDC
C6-C7	10-281282-224	Capacitor, .22 μfd, Metalized, 50 WVDC
C8	287614-393	Capacitor, .039 μfd, Ceramic, 50 WVDC
C9	287614-103	Capacitor, .01 μfd, Ceramic, 50 WVDC
C10-C11	10-281282-224	Capacitor, .22 μfd, Metalized, 50 WVDC
C12	287614-472	Capacitor, .0047 μfd, Ceramic, 50 WVDC
C13	10-290482-226	Capacitor, 22 μfd, 15V ±10%, Electrolytic
C14	288755-103	Capacitor, .01 μfd, Ceramic, 50 WVDC
C15	287614-472	Capacitor, .0047 μfd, Ceramic, 50 WVDC
C16	287614-103	Capacitor, .01 μfd, Ceramic, 50 WVDC
C17	287614-393	Capacitor, .039 μfd, Ceramic, 50 WVDC
C18	2-295781-812	Capacitor, .0082 μfd, Mylar, 100 WVDC
C19	262585-106	Capacitor, 10 μfd, 20V ±20%, Electrolytic
C20	2-295781-103	Capacitor, .01 μfd, Mylar, 100 WVDC
C21	292710-105	Capacitor, 1 μfd, Ceramic, 50 WVDC
C22	287614-103	Capacitor, .01 μfd, Ceramic, 50 WVDC
C23-C24	288755-104	Capacitor, .1 μfd, Ceramic, 50 WVDC
C25	10-263695-105	Capacitor, 1 μfd, Tantalum, 20 WVDC, Electrolytic
C26	2-295781-103	Capacitor, .01 μfd, Mylar, 100 WVDC
C27	292710-105	Capacitor, 1 μfd, Ceramic, 50 WVDC
C28	262585-106	Capacitor, 10 μfd, 20V ±20%, Electrolytic
C29	2-295781-103	Capacitor, .01 μfd, Mylar, 100 WVDC
C30-C31	269255-337	Capacitor, 330 μfd, 35V -10, +100%, Electrolytic
C32-C33	262585-106	Capacitor, 10 μfd, 20V ±20%, Electrolytic
C34-C35	262956-226	Capacitor, 22 μfd, Tantalum, 10V ±20%, Polarized
C36	10-288757-330	Capacitor, 330 pfd, Ceramic, 50 WVDC
C37-C38	288755-104	Capacitor, .1 μfd, Ceramic, 50 WVDC
C39-40	287614-473	Capacitor, .047μfd, Ceramic, 50 WVDC
CR1-CR2	244896	Diode, 1N458A
CR3-CR4	Not Used	
CR5-CR10	280440	Diode, 1N4148
CR11-CR14	289256-7	Diode, 1N4007
CR15	286018-2	Bridge Rectifier
CR16-19	289662	Diode, 1N914

ELECTRICAL PARTS LIST
BOARD ASSEMBLY 894952
FIGURE 6-2 (Continued)

SYMBOL NUMBER	PART NUMBER	DESCRIPTION
Q1	281702-2	Transistor, 2N4401
Q2-Q4	281703-2	Transistor, 2N4403
Q5	281292-3	Transistor, 2N4393
Q6	281703-2	Transistor, 2N4403
Q7	281292-3	Transistor, 2N4393
Q8	281703-2	Transistor, 2N4403
Q9	281857-2	Transistor, 2N5033
Q10	281703-2	Transistor, 2N4403
Q11	281292-3	Transistor, 2N4393
Q12	281857-2	Transistor, 2N5033
Q13	281702-2	Transistor, 2N4401
Q14	281703-2	Transistor, 2N4403
Q15	230058-1	Transistor, 2N4918
Q16-Q17	230057-1	Transistor, 2N4921
Q18	230058-1	Transistor, 2N4918
R1-R3		For Bridge Completion
R4		For Calibration
R5	269085-502	Resistor, Variable, 5 Kohms
R6-R7	269085-103	Resistor, Variable, 10 Kohms
R8-R9	269085-502	Resistor, Variable, 5 Kohms
R10	269085-202	Resistor, Variable, 2 Kohms
R11	269085-103	Resistor, Variable, 10 Kohms
R12	1-288308-560R0	Resistor, 560 ohms
R13-R14	269085-203	Resistor, Variable, 20 Kohms
R15-R16	269085-103	Resistor, Variable, 10 Kohms
R17	269085-202	Resistor, Variable, 2 Kohms
R18	R1-288308-49502	Resistor, 495 Kohms
R19-R20	R1-288308-45000	Resistor, 4.5 Kohms
R21	R1-288308-49502	Resistor, 495 Kohms
R22-R23	R1-288308-50000	Resistor, 5 Kohms
R24	R1-288308-100R0	Resistor, 100 ohms
R25	R1-288308-18001	Resistor, 18 Kohms
R26-R27	R1-288308-20001	Resistor, 20 Kohms
R28-R29	R1-288308-10001	Resistor, 10 Kohms
R30-R31	R1-288308-100R0	Resistor, 100 ohms
R32	R1-288308-200R0	Resistor, 200 ohms
R33	R1-288308-600R0	Resistor, 600 ohms
R34	R1-288308-10000	Resistor, 1 Kohms
R35	R1-288308-20000	Resistor, 2 Kohms
R36	R1-288308-60000	Resistor, 6 Kohms

ELECTRICAL PARTS LIST
BOARD ASSEMBLY 894952
FIGURE 6-2 (Continued)

SYMBOL NUMBER	PART NUMBER	DESCRIPTION
R37-R39	5-241111-103	Resistor, 10 Kohms
R40-R41	5-241111-156	Resistor, 15 Mohms
R42	5-241111-103	Resistor, 10 Kohms
R43-R44	5-241111-156	Resistor, 15 Mohms
R45-R46	5-241111-103	Resistor, 10 Kohms
R47	R1-288308-42900	Resistor, 4.29 Kohms
R48	5-241111-102	Resistor, 1 Kohms
R49	5-241111-203	Resistor, 20 Kohms
R50	5-241111-103	Resistor, 10 Kohms
R51	5-241111-104	Resistor, 100 Kohms
R52	5-241111-103	Resistor, 10 Kohms
R53	5-241111-104	Resistor, 100 Kohms
R54	5-241111-103	Resistor, 10 Kohms
R55	1 288308-10000	Resistor, 1 Kohms
R56	1-288308-50001	Resistor, 50 Kohms
R57	5-241111-103	Resistor, 10 Kohms
R58	5-241111-203	Resistor, 20 Kohms
R59	5-241111-102	Resistor, 1 Kohms
R60	5-241111-101	Resistor, 100 ohms
R61-R62	5-241111-471	Resistor, 470 ohms
R63	5-241111-202	Resistor, 2 Kohms
R64	5-241111-472	Resistor, 4.7 Kohms
R65-R66	5-241111-202	Resistor, 2 Kohms
R67	5-241111-472	Resistor, 4.7 Kohms
R68	5-241111-202	Resistor, 2 Kohms
R69-R70	5-241111-471	Resistor, 470 ohms
R71-R73	5-241111-101	Resistor, 100 ohms
R74-R78	5-241111-153	Resistor, 15 Kohms
R79	5-241111-103	Resistor, 10 Kohms
R80	R1-288308-10000	Resistor, 1 Kohms
R81	R1-288308-90000	Resistor, 9 Kohms
R82	5-241111-105	Resistor, 1 Mohm
R83		
R84	269085-202	Resistor, Variable, 2 Kohms
R85	269085-502	Resistor, Variable, 5 Kohms
R86	5-241111-562	Resistor, 5.6 Kohms
R87	5-241111-302	Resistor, Variable, 3 Kohms
R88	269085-102	Resistor, Variable, 1 Kohms
R89	269085-502	Resistor, Variable, 5 Kohms
R90-R91		

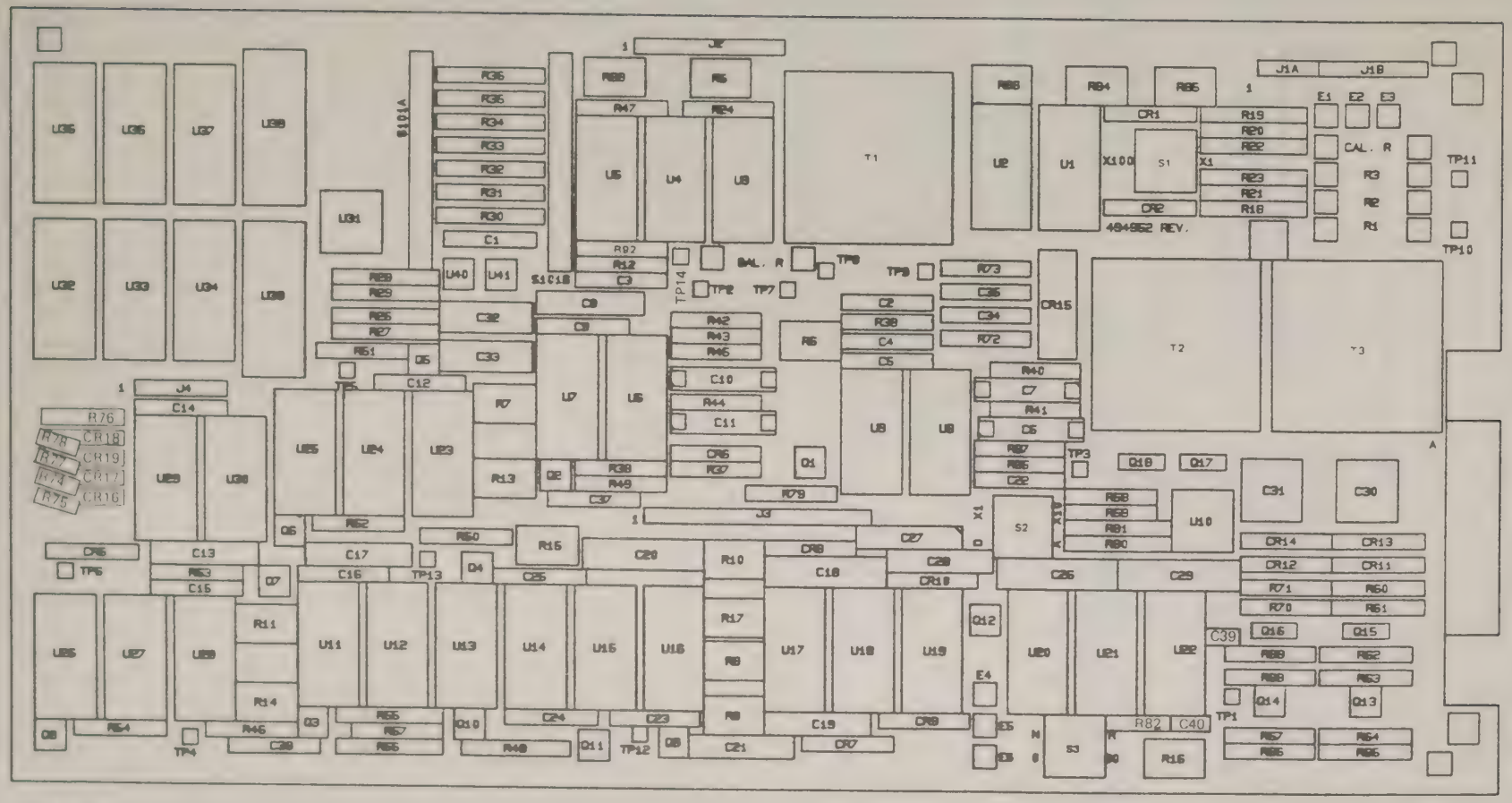
ELECTRICAL PARTS LIST
BOARD ASSEMBLY 894952
FIGURE 6-2 (Continued)

SYMBOL NUMBER	PART NUMBER	DESCRIPTION
R92	R1-288308-30800	Resistor, 3.08 Kohms
S1	293438	Switch, Slide
S2-S3	295214	Switch, Slide, Dual, SPDT
S101	295159	Switch, Rotary
T1	296102	Transformer (A-P)
	297100	Insulator (used under each transformer)
T2-T3	296101	Transformer
U1	292719	I.C., OP-111EY*
U2	295213	Resistor Network
U3	295212	Resistor Network
U4	291062-3	I.C., TL084CN*
U5	295211	Resistor Network
U6	291062-3	I.C., TL084CN*
U7	295204	Resistor Network
U8	291062-3	I.C., TL084CN*
U9	295204	Resistor Network
U10	294992-1	I.C., OP-14CP*
U11	295204	Resistor Network
U12	291062-3	I.C., TL084CN*
U13	295205	Resistor Network
U14	295206	Resistor Network
U15	291062-4	I.C., TL084CN*
U16	295207	Resistor Network
U17	295208	Resistor Network
U18	291062-3	I.C., TL084CN*
U19	295209	Resistor Network
U20	295207	Resistor Network
U21	291062-3	I.C., TL084CN*
U22	295210	Resistor Network
U23	295203	Resistor Network
U24	291062-3	I.C., TL084CN*
U25-U26	295201	Resistor Network
U27	291062-3	I.C., TL084CN*
U28	295203	Resistor Network
U29	295202	Resistor Network
U30	295160	Transistor Array, CA3086*
U31	283948	I.C., MC1458PU3
U32-U37	290305-516	I.C., CMOS, MC14516BCP
U38-U39	294184-2	I.C., CMOS, AD7531KN*
U40	289388	I.C., Regulator, MC78L05C*
U41	289897	I.C., MC79L05ACP*

*All IC's must have proper run-in time before use.

ELECTRICAL PARTS LIST
BOARD ASSEMBLY 894952
FIGURE 6-2 (Continued)

SYMBOL NUMBER	PART NUMBER	DESCRIPTION
TP1-13	265763-3	Contact
E1-E6	265154	Contact
	292709-16	Socket
	292709-18	Socket
J1	1-287495-11	Connector
J2	1-287495-10	Connector
J3	1-287495-15	Connector
J4	1-287495-6	Connector
		-- -- -- -- -- * -- -- -- -- --
	269289	Heatsink
	293848-3	Insulator
	31-119918-40005	Screw
	31-119988-40	Nut



REV. R

FIGURE 6-2 BOARD ASSEMBLY 894952

APPENDIX

SCHEMATIC DRAWINGS

This section contains complete schematic drawings for this Gould product. The following schematics were of the latest revision at time of printing. The schematics are arranged in numerical order by drawing number. All documents included in this section are listed below, in alphanumeric order by title, along with their drawing numbers to help locate them. The part number of any PC board assembly may be obtained by replacing the initial "2" in the schematic number with an "8".

ALPHABETICAL LIST OF SCHEMATICS

DESCRIPTION OF ASSEMBLY	SCHEMATIC DRAWING NUMBER	REVISION LEVEL
Attenuator Adapter 11-5407-35	297039	--
Board Assy. Gain Control	897419	--
Carrier Amp. Assy.	bi2562	--
Carrier, Board Assy.	894952	U1

PARTS LIST
ADAPTER, ATTENUATOR, 11-5407-35
SCHEMATIC NO. 297039

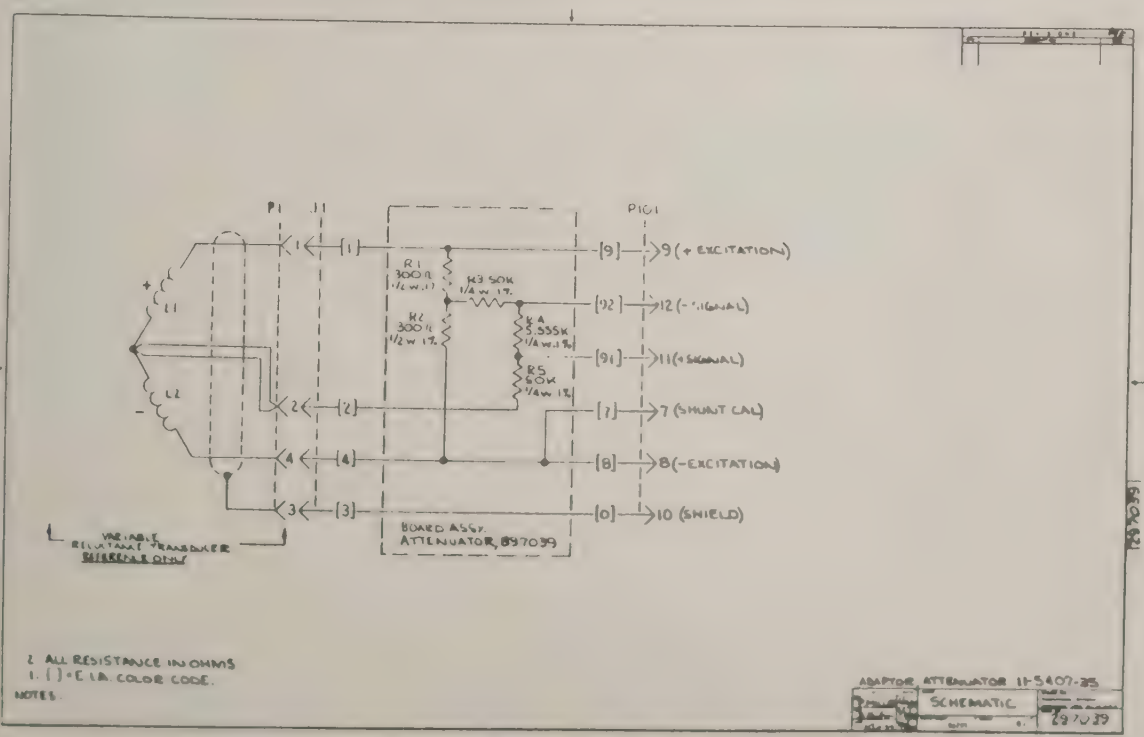
SYMBOL NUMBER	PART NUMBER	DESCRIPTION
J1	297018	Connector, Male
P101	288928	Connector
		-- -- -- -- -- * -- -- -- -- --
	288930	Contact, Pins
R1-2	10-240368-300R0	Resistor, 300 ohms
R3	R1-284694-50001	Resistor, 50K ohms
R4	R1-284694-55550	Resistor, 5.555K ohms
R5	R1-284694-50001	Resistor, 50K ohms

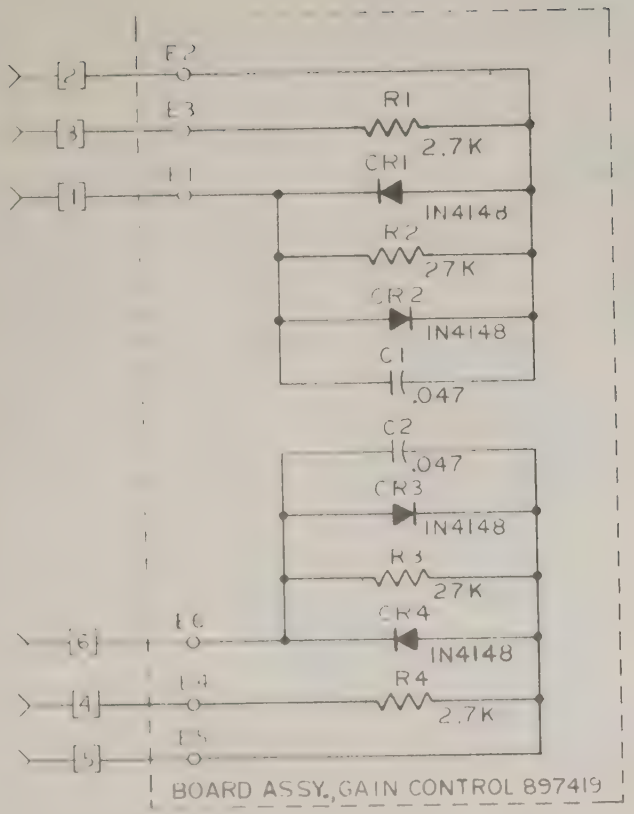
Calibration:

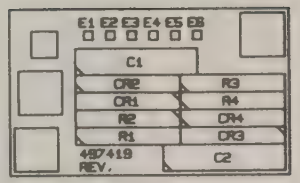
No calibration is required.

Note:

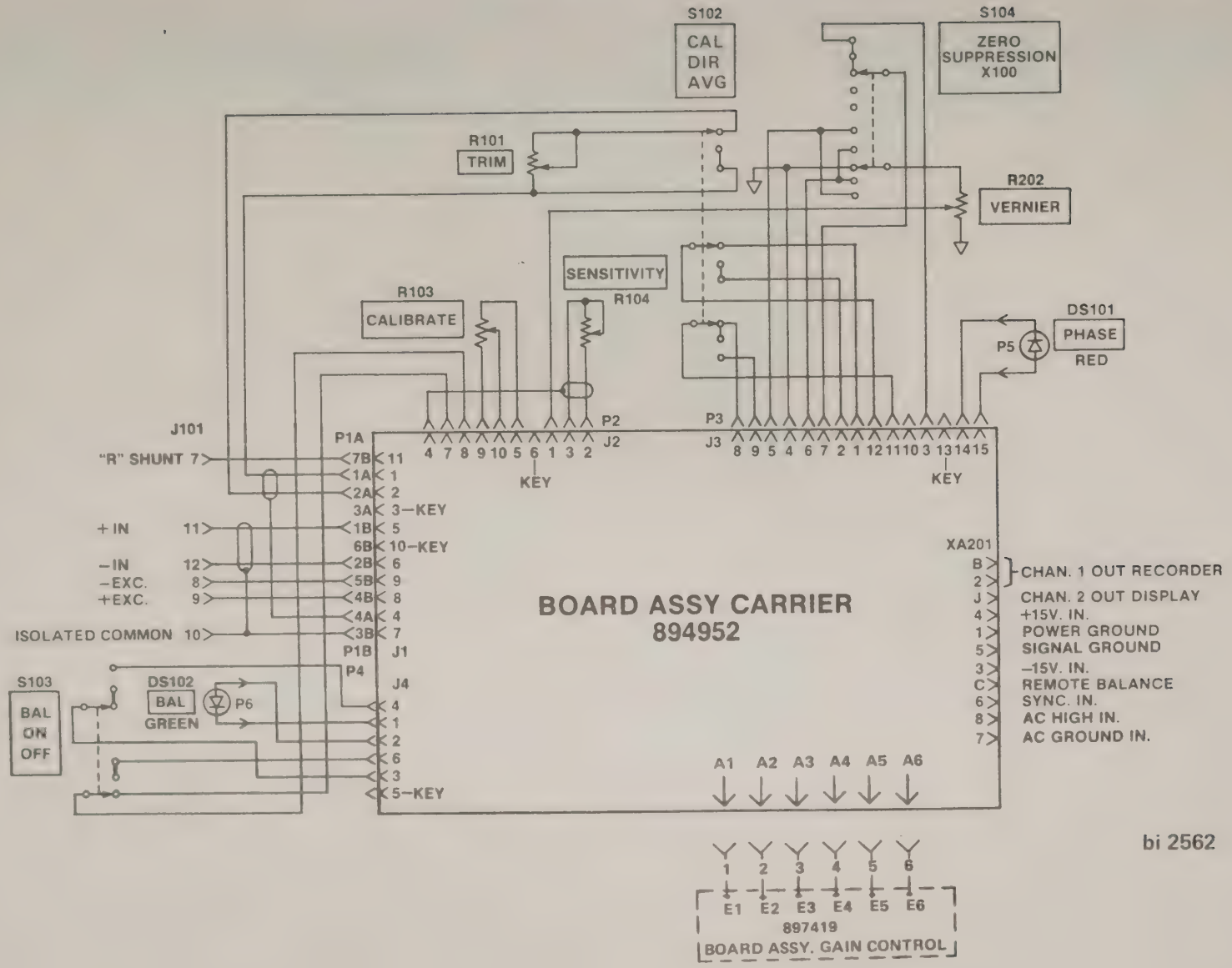
If this adapter is suspect, a simple point-to-point resistance check should be adequate to determine if the unit is operational.

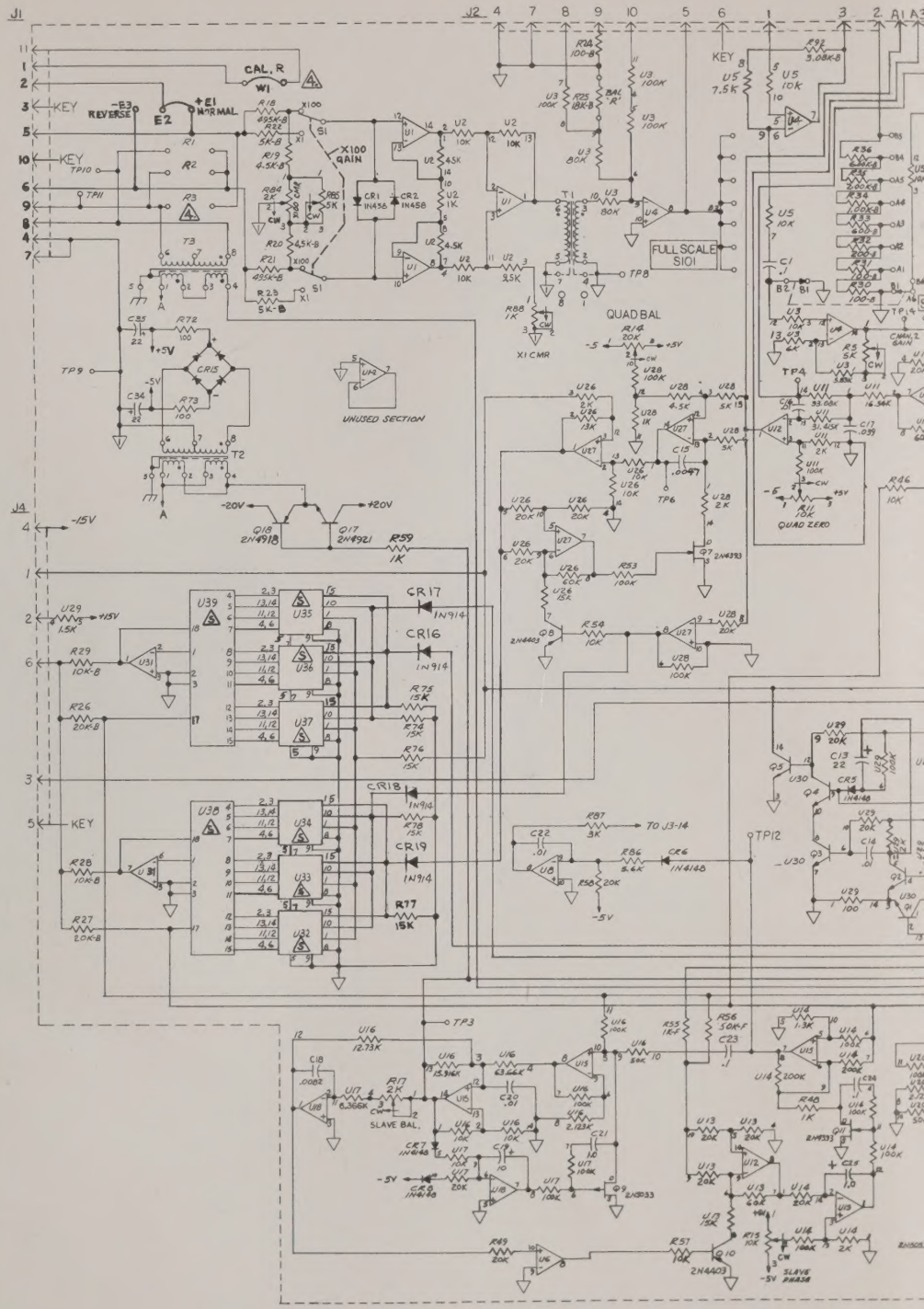






SYMBOL NUMBER	PART NUMBER	DESCRIPTION
	897419	Board Assy.
C1-2	287614-473	Capacitor, .047 ufd
CR1-4	280440	Diode, 1N4148
R1	5-241111-272	Resistor, 2.7K ohms
R2-3	5-241111-273	Resistor, 27K ohms
R4	5-241111-272	Resistor, 2.7K ohms


S102
CAL
DIR
AVG
S104
ZERO
SUPPRESSION
X100
R101
TRIM
R202
VERNIER
SENSITIVITY
R104
R103
CALIBRATE
DS101
PHASE
RED
P5
J101
"R" SHUNT 7
+IN 11
–IN 12
–EXC. 8
+EXC. 9
ISOLATED COMMON 10
P1A
P1B
J1
P2
J2
P3
J3
KEY
BOARD ASSY CARRIER
894952
XA201
B CHAN. 1 OUT RECORDER
2
J CHAN. 2 OUT DISPLAY
4 +15V. IN.
1 POWER GROUND
5 SIGNAL GROUND
3 –15V. IN.
C REMOTE BALANCE
6 SYNC. IN.
8 AC HIGH IN.
7 AC GROUND IN.
S103
BAL
ON
OFF
DS102
BAL
GREEN
P6
P4
J4
A1 A2 A3 A4 A5 A6
E1 E2 E3 E4 E5 E6
897419
BOARD ASSY. GAIN CONTROL
bi 2562



4. R1, R2, R3, & CAL. R ARE BRIDGE COMPLETION & CALIBRATION RESISTORS.

3. ⏚ = ISOLATED GROUND.

2. RESISTOR TOLERANCES:
   B= .1%, F= 1%, UNMARKED= 5%, 1/4 WATT.

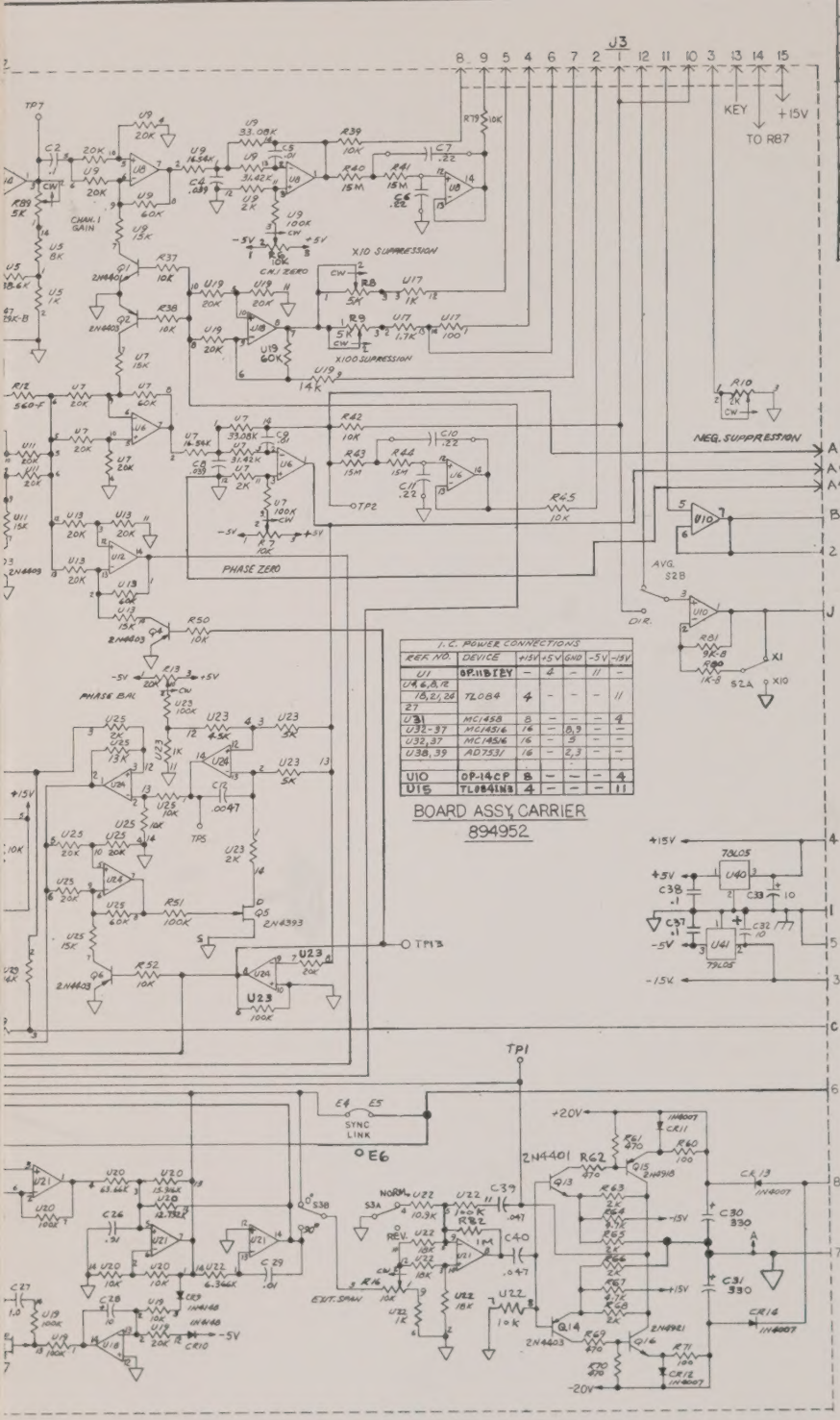
1. UNLESS OTHERWISE INDICATED:
   ALL CAPACITANCE IN MICROFARADS,
   ALL RESISTANCE IN OHMS.

NOTES:

S THIS BOARD CONTAINS STATIC SENSITIVE AND MUST BE HANDLED PER MEI-0011.

REVISIONS

SYM.	DESCRIPTION	DATE	APPROVAL
F-1	REVISED & REDRAWN DCN 29814	7-8-82	SWARTZ
G-1	REVISED PER DCN 29941	9-14-82	SWARTZ
H-1	NOT AFFECTED DCN 30018	10-12-82	SWARTZ
J-1	NOT AFFECTED DCN 29944	10-14-82	SWARTZ
K-1	REVISED PER DCN 30801	2-11-83	SWARTZ
L-1	REVISED PER DCN 30517	4-20-83	P. MILLER
M-1	REVISED PER DCN 30605	5-13-83	SWARTZ
N-1	U1 WAS TL084, U15 WAS TL084, U10 WAS MC1458 DCN 30728	7-7-83	SWARTZ
P-1	NOT AFFECTED PER DCN 30926	9-19-83	S JONES
R-1	NOT AFFECTED PER DCN 31396	4-17-84	S. JONES
S-1	NOT AFFECTED PER DCN 31445	5-4-84	S. JONES
T-1	NOT AFFECTED PER DCN 31624	8-16-84	J. RIVERA
U-1	REVISED PER DCN 31814	11-15-84	DUPAL



MP MASTER
MA34592